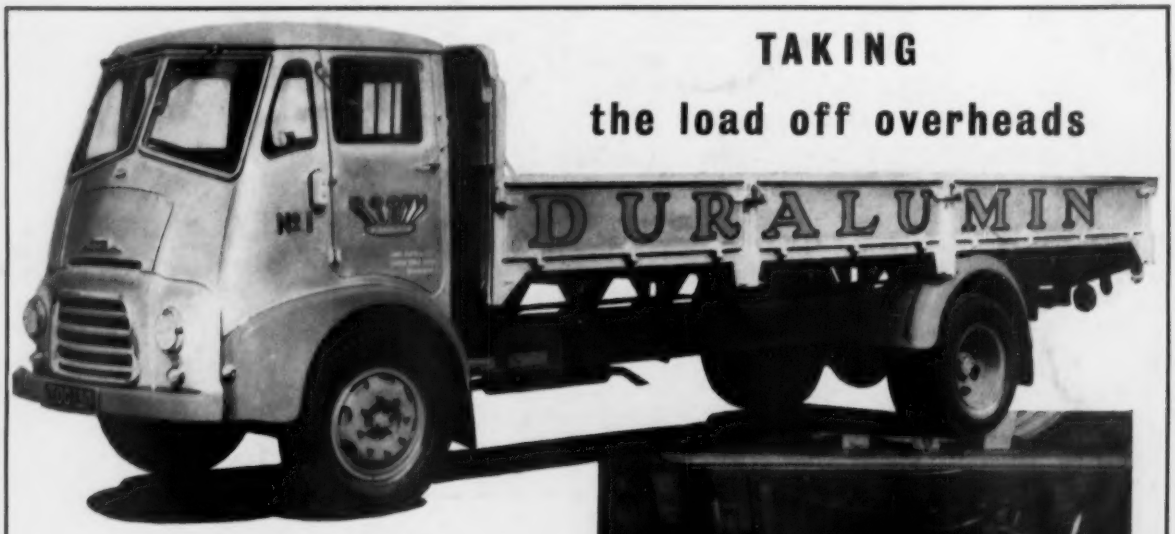
AUTOMOBILE ENGINEER

DESIGN · PRODUCTION · MATERIALS

Vol. 46 No. 12 **NOVEMBER 28, 1956** PRICE: 3s. 6d.

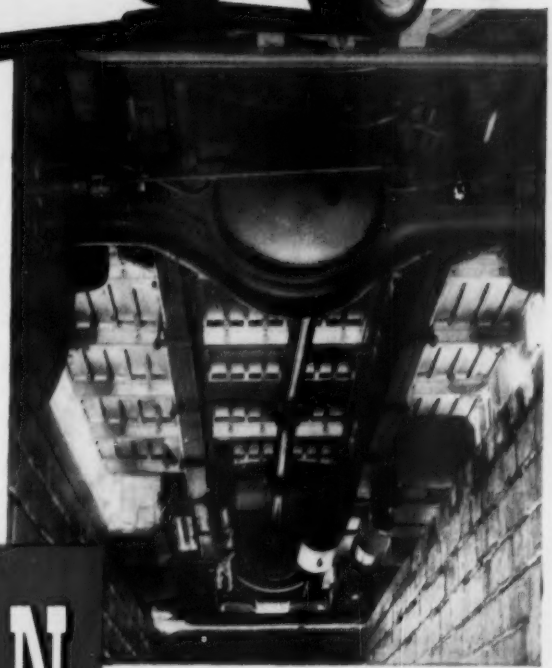
TAKING

the load off overheads



7-ton B.M.C. forward control Diesel with chassis supplied by Premier Motor Company (Birmingham), and fitted with Baico extension and 21-ft. body. Bodywork by Duramin Engineering Company—an entirely independent organisation.

In this drop-sided truck, 'Duralumin' saves wear, tare, tyres, fuel and tax. Mounted on a standard B.M.C. chassis, its capacity has been increased by a third, using a Baico extension and a 21-ft. 'Duralumin' body. The weight, however, is still sufficiently low to qualify for the same rate of tax. Strong as steel yet only a third its weight, corrosion-resistant, hardwearing and easily cleaned, 'Duralumin' offers important advantages to vehicle operators and constructors.



Mechanic's eye-view of the chassis showing the Duramin Engineering Company's tongued and grooved 'Duraplank' flooring made from 'Duralumin'.

DURALUMIN

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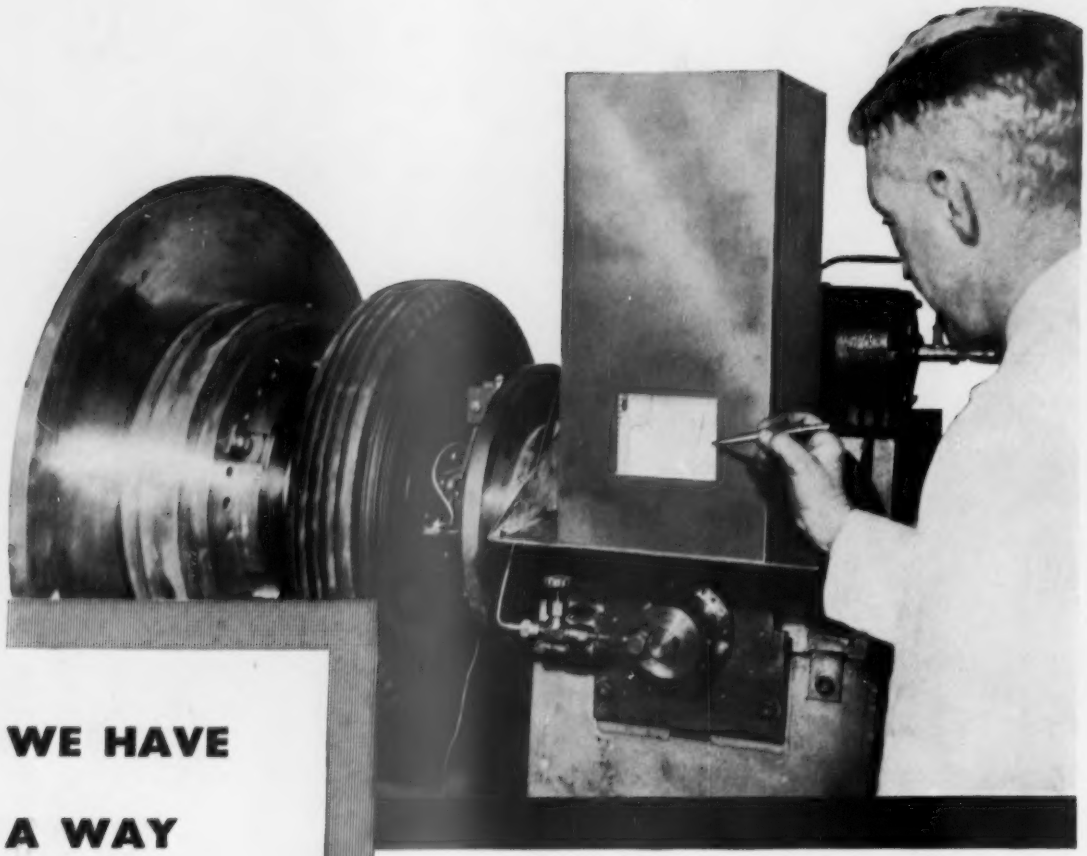
Extrusions, large forgings, plate, sheet, strip, tubes and wire in brass and copper, as well as light alloys.

TGA BT97A



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When high performance counts

you can rely on MINTEX

MINTEX BRAKE AND CLUTCH LINERS ARE MANUFACTURED BY BRITISH BELTING & ASBESTOS LIMITED, CLECKHEATON, YORKSHIRE

Double Frame Construction
gives extra rigidity at maximum speeds and feeds.

Pushbutton Control
for manual operation.

Programme Control
for automatic work cycle to all machine motions in any sequence — roughing and finishing with different feeds on the same cycle — quick changeover for economic hobbing of small batch work.

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Hydraulic Automatic Locking
of hob slide, carriage, work stay, work arbor support and overarm brace during work cycle — hydraulic work clamping and movement of overarm brace.

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24, by variable speed gear for FN6 and FP4 machines. Infinitely variable from 20–400 r.p.m. for larger machines.

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18 for smaller machines and up to 36 on FN9 and FP7.

Independent Roughing and Finishing Feeds
selected in automatic work cycle by programme control or manually by pushbutton.

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Max. pitch hobbed:	d.p.	6.35	3.63	4.23	2.82
	module	4	7	6	9
Max. workpiece dia. hobbed with work-stay in position		11.81"	23.62"	23.62"	35.43"
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A recent issue of our journal "Wiggin Nickel Alloys" contains an article on Aston Martin sports cars from 1913 to the present day.
In the exhaust systems of today's Aston Martin sports-racing cars, the nickel alloys, Nimonic 75 and Inconel are employed, and the article explains why these heat-resisting materials were chosen.

Other features in this issue include:

'Keeping the Policeman Mobile'—valve reclamation by use of B.A.C. Brightray Welding Wire.

'Ship's Emergency Electricity Supply'—dealing with the Allen 350 kW gas-turbine set.

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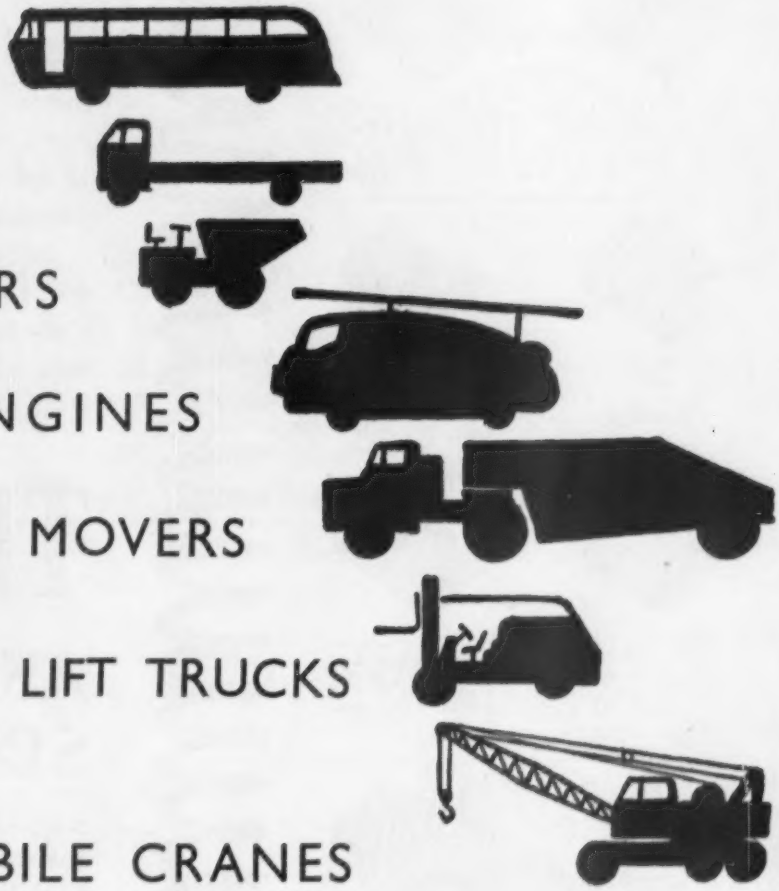

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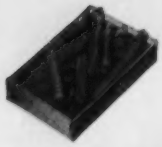

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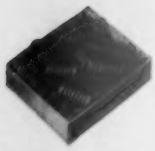

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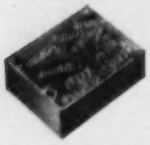

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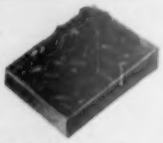
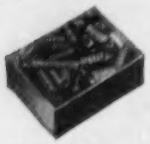


No. 388. ¼ gross Assorted Small Expansion Springs. ½" to 1¼", 18G to 21G. 9/6 each.



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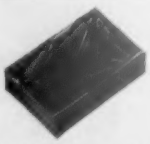
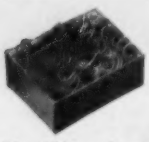
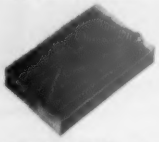


No. 466. ¼ gross Assorted Small Expansion Springs ¾" to 1½" long, 3/32" to 3/16" diam., 21G to 24G. 6/6 each.



No. 1013. 1 gross Small Coil Compression Springs, ¾" to 1½" long, 3/32" to 7/16" diam., 24G to 19G. 6/- each.



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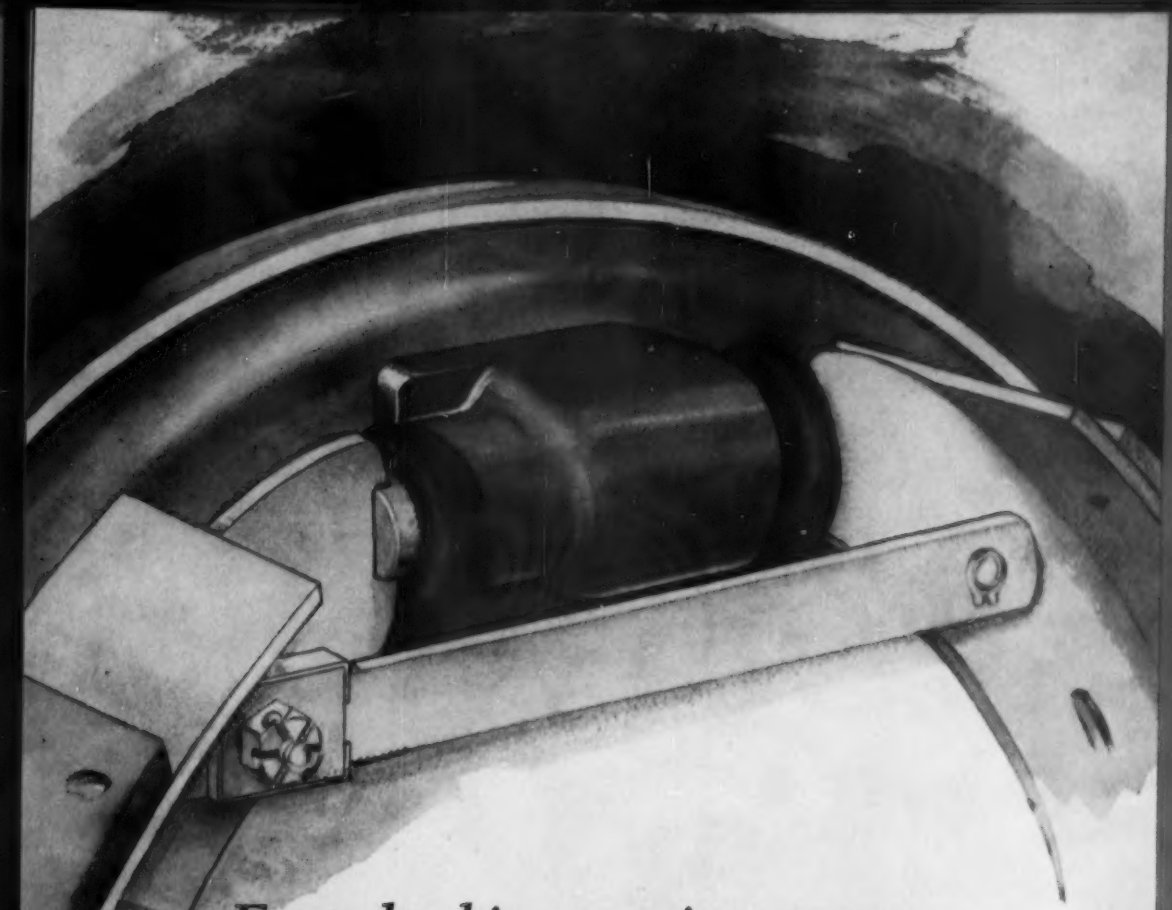

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THE LOCKHEED RANGE OF BRAKES
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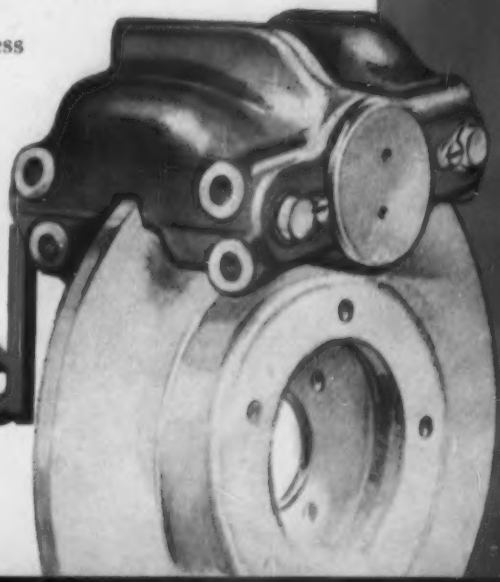
The Lockheed Brakemaster has outstanding stability and performance under the most severe conditions, and with just the right degree of assistance from its servo unit to make driving easier.

Lockheed two-leading shoe brakes, extensively used in great quantities, are too well-known to need further comment.

Lockheed's latest disc-brake embodies the experience of many years of development.

A fine, powerful brake giving a consistent performance, with the generous lining thickness essential to this type of brake. Simple, compact and easy to build into both the rear and the front ends.



Lockheed

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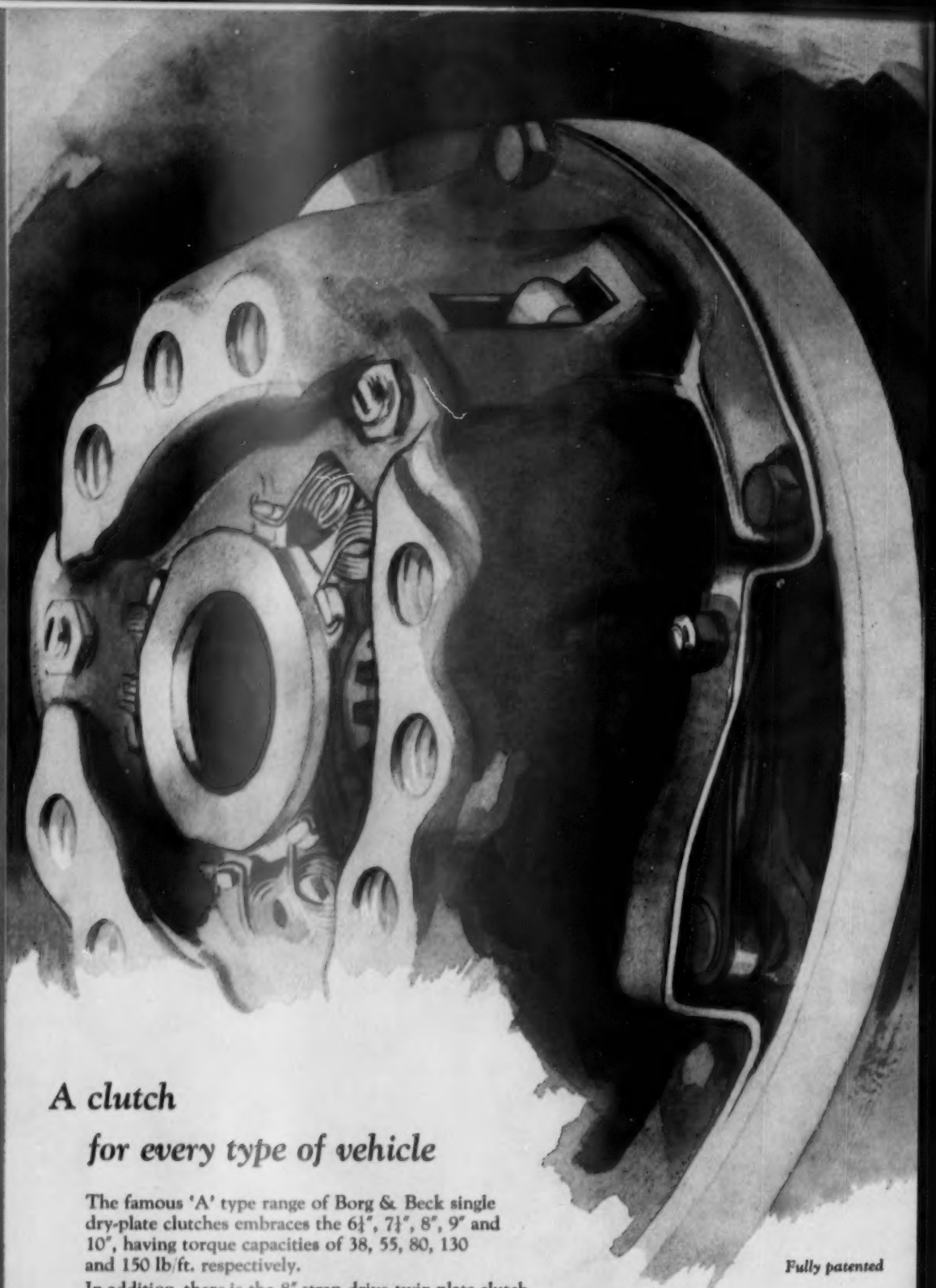

A clutch for every type of vehicle

The famous 'A' type range of Borg & Beck single dry-plate clutches embraces the 6¼", 7¼", 8", 9" and 10", having torque capacities of 38, 55, 80, 130 and 150 lb/ft. respectively.

In addition, there is the 8" strap drive twin plate clutch.

Borg & Beck clutches are fitted to more than 80% of Britain's vehicles and embody many features which have become famous for their influence on smooth performance and durability.

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Purolator 'Micronic' oil filters earned their fine reputation by their unequalled efficiency in removing the microscopic particles from the engine oil.

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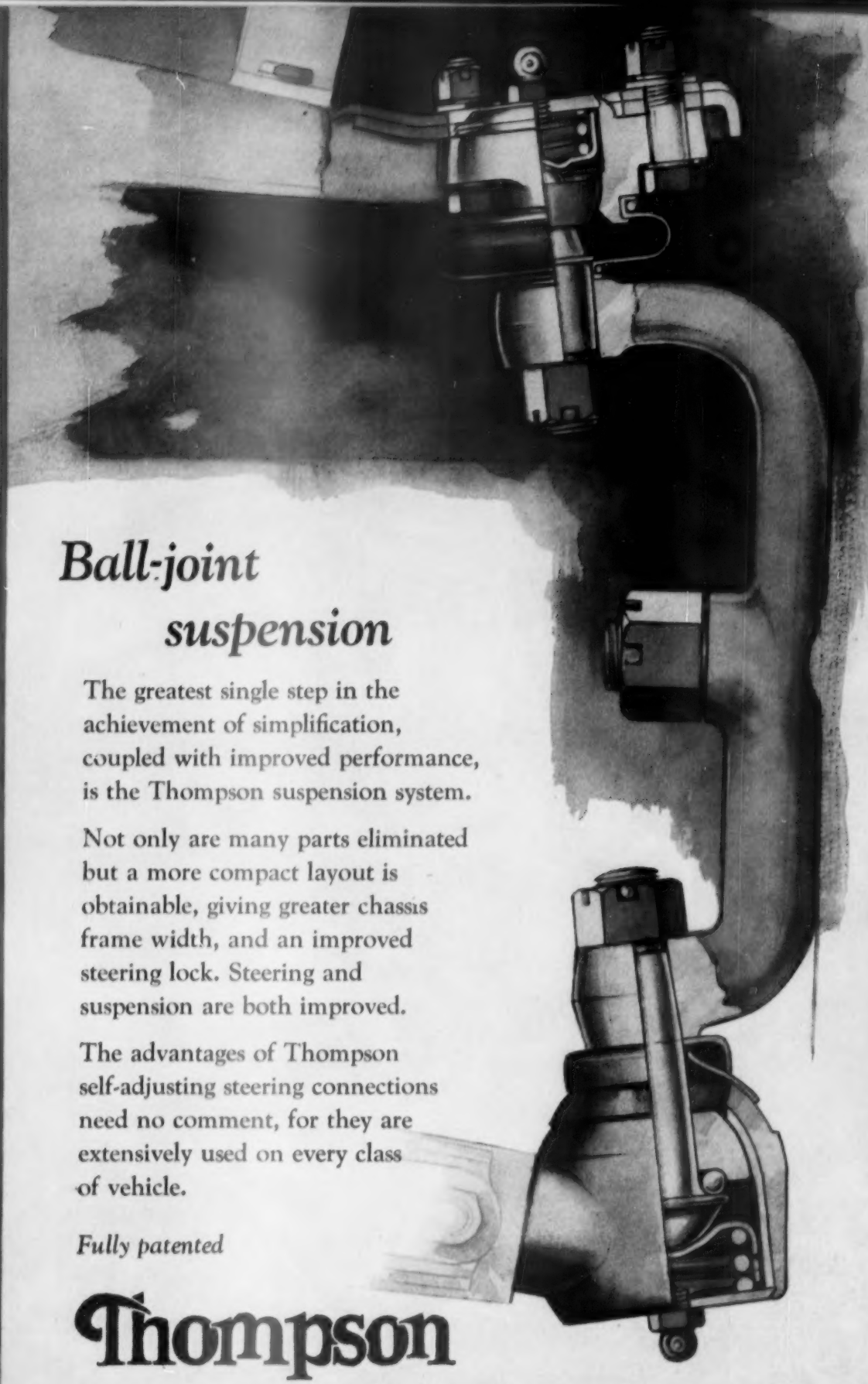

Ball-joint suspension

The greatest single step in the achievement of simplification, coupled with improved performance, is the Thompson suspension system.

Not only are many parts eliminated but a more compact layout is obtainable, giving greater chassis frame width, and an improved steering lock. Steering and suspension are both improved.

The advantages of Thompson self-adjusting steering connections need no comment, for they are extensively used on every class of vehicle.

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BUT WITHOUT PEDAL

EASILY INCORPORATED
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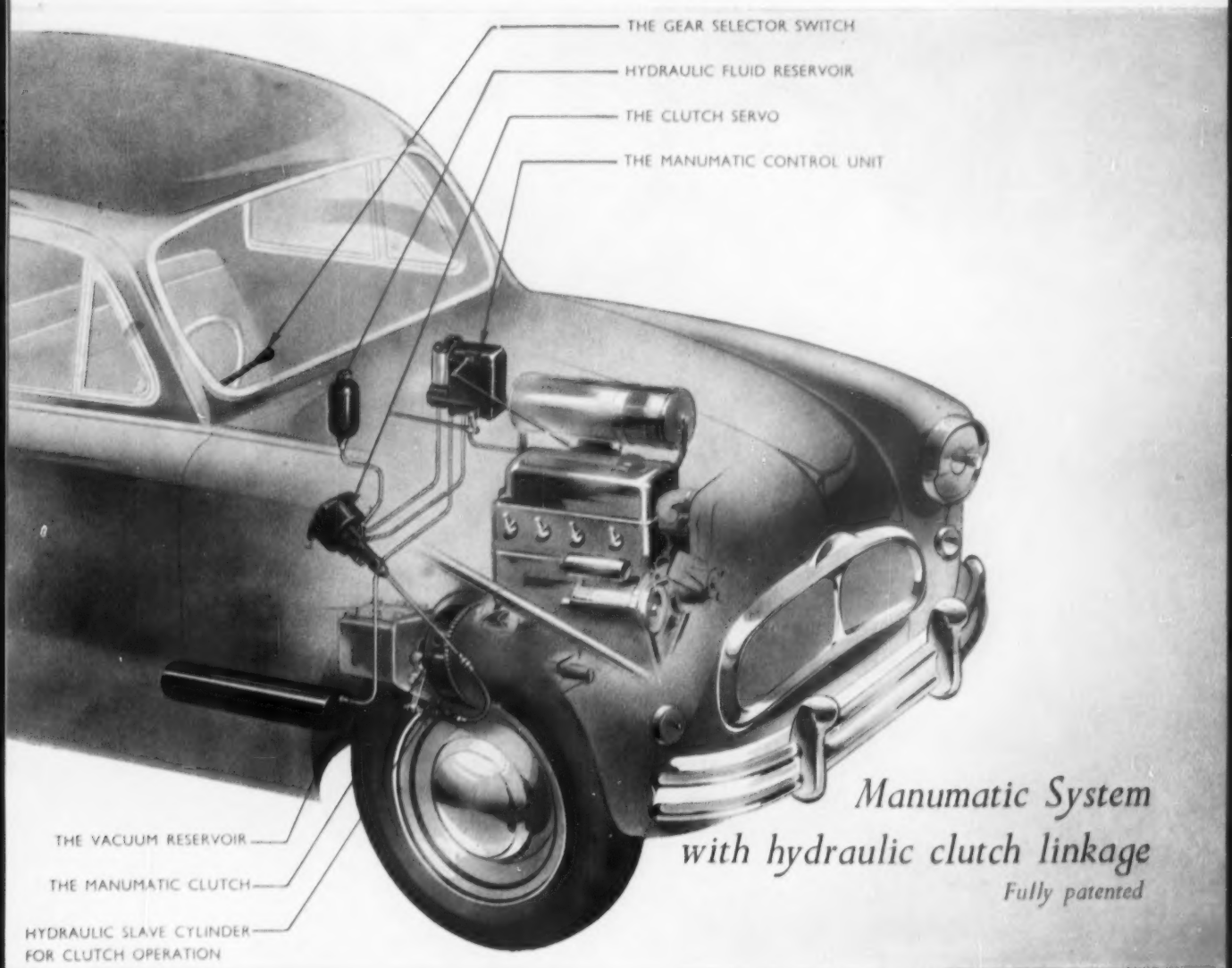
system for the popular car



Manumatic System
with hydraulic clutch linkage
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Evolved expressly
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Other firms come out with crashing great photos
of power tools *in use*. They say simple bold things
like **the finest small power tools on earth.**
They *tell* people how good they are and why
their tools are the best and so on.
Customers don't want all this stuff about
Little Horses and if you'll pardon the expression
Personal Chats from you
about how jolly smart you are. They want good
'selling' copy that gives reasons . . ."

The Old Boy coughed and we braked heavily.
" Boy " he said " There seems to be some mistake.
Do you suggest we should chaffer in the
market place like some seller of Oriental Rugs?
Am I to become a Super-Salesman?
Do you imply that we are *in competition*
with some other makers of small tools?
Well — *do* you? Name them, Sir, name them, for
their names will be news to me ".
Conceited old fathead.

PUT POWER INTO YOUR HANDS

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A leap in the dark!

"'TIS THE ROUNDHEADS, Sir Percy. Haste thee, Milord — jump for it!"

"But 'tis dark outside," said Sir Percy plaintively — off the battlefield he was a man of cautious disposition — "'tis wondering where to jump I am?"

"'Tis no time to ponder" retorted the Squire, "Haste!"

"Very well then, I suppose thou knowest best." Sir Percy grasped his sword, swung his cloak, and leapt into a world of darkness; he was pleasantly surprised to land on something soft and yielding. "Gad!" he beamed, "the age of miracles is not yet past." From beneath him, oddly muffled, the Squire's voice choked; "'Twould be uncommon kind of milord to remove his scabbard from the small of my back."

"Faith!" cried the cavalier — "here is a waggish situation indeed. Meseems I made a splendid landing on thy broad and faithful back. And where didst *thou* come to earth, old friend?"

The Squire squirmed uneasily. "Verily I could not swear to it, but if I mistake me not, we are in the cattleyard." His movements were accompanied by an odd squelching sound. "Verily thou wert unfortunate," said Sir Percy with soldierly sympathy — "perhaps that will teach thee the folly of a spring in the dark. And speaking of springs" — he spake with a knowledge surprising in one of that period — "Didst know that the most inferior springs may look exactly like a genuine high precision job, guaranteed for years of high performance? What! not interested in springs? Ah, well, perhaps a tub would suit thee better." He ambled off into the darkness . . .

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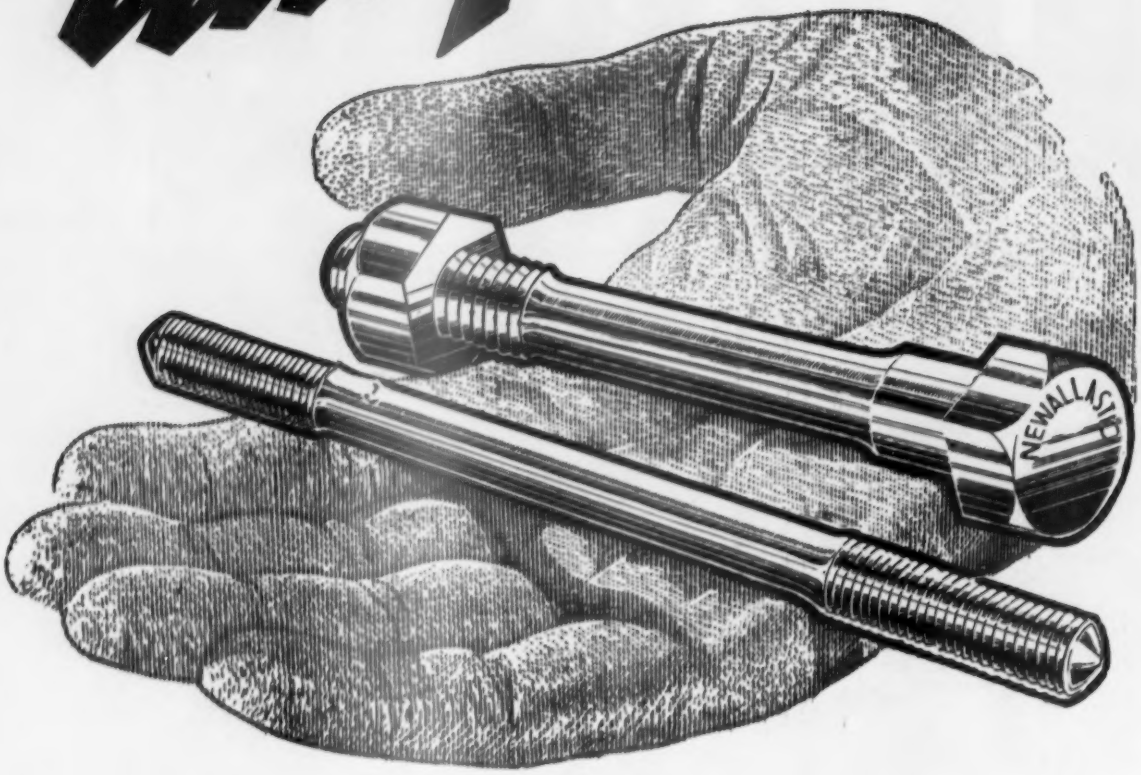

"Newallastic" bolts and studs have qualities which are absolutely unique. They have been tested by every known device, and have been proved to be stronger and more resistant to fatigue than bolts or studs made by the usual method.

G. P. Newall & Co., Ltd.

POSSILPARK GLASGOW · N

Illustration by courtesy of F. C. Blackwell & Co. Ltd.

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AN EXCELLENT GENERAL PURPOSE TOOL STEEL

KE 672 is known universally as the original " Blue Line Die Steel ". This Steel can be machined with ease and oil hardened with a low distortion factor. Many years of service have proved that, when worked under normal conditions, KE 672 is trouble free and ideal for a wide variety of blanking, pressing and piercing operations.

A FIRST CLASS LOW TEMPERATURE OIL HARDENING TOOL STEEL WITH DEEP HARDENING PROPERTIES

KE 637 can be machined quite readily. For gauges and tools of intricate shape where final grinding is not permissible KE 637 is an ideal steel for hardening with minimum distortion.

AN OIL HARDENING TOOL STEEL WITH DEEP HARDENING PROPERTIES AND EXTRA WEAR RESISTANCE

KE 595 is more highly alloyed than KE 672 and KE 637 and is capable of wider application. The Steel can be deep hardened in comparatively large sections and is suitable for presswork involving greater tool mass. Excellent torsional properties in the hardened and tempered state make KE 595 an excellent Steel for Taps, Reamers, etc. Also used as tabletting punches and dies for the less abrasive compounds. KE 595 can be heat treated with a minimum of movement.

A 2% CARBON 14% CHROME HIGH DUTY TOOL STEEL

KE 970 is hard, durable and dense. The Steel can be heat treated with a minimum of distortion, is highly resistant to abrasion, immune from sinking in use and, when polished, does not tarnish easily. After hardening, KE 970 can be tempered over a much wider range than is permissible with ordinary Alloy Tool Steels and is used for a variety of exacting blanking and pressing operations, as moulds for ceramics, tabletting punches and sleeves for abrasive synthetics, etc. In cases where increased toughness is desired at the expense of a slight reduction in hardness we also supply KE 961 1½% Carbon 14% Chrome Steel.

We make many other types of Tool Steel for various applications. If further details are required we shall be pleased to arrange for one of our local Technical Representatives to call or we will send you a copy of our booklet " K.E. High Grade Tool Steels for Cold Work ". All our Tool Steels are despatched in the annealed condition, a process which is very carefully controlled as regards time, temperature and atmosphere, to give optimum machinability.

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FOR WELDING CUTTING HEATING FLAME CLEANING

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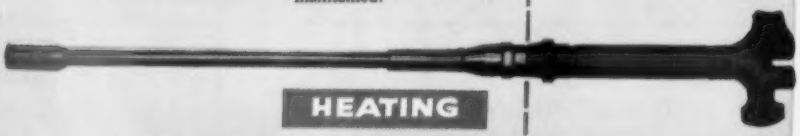
WELDING

A complete range of swaged or detachable tips is available covering all welding requirements up to ¼".

CUTTING

The cutting attachment will cut steel up to 2" thick. The highest degree of safety is ensured by the use of *nozzle-mixing*, limiting any possibility of backfire to the nozzle itself and allowing maximum cutting speeds to be maintained.



HEATING

The nozzles screw on to the straight welding neck or on to flexible necks which can be bent to any angle.

FLAME CLEANING

Flame cleaning attachments screw directly into the mixer and consist of a bent neck or a straight neck with a range of detachable flat or round nozzles.

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BRITISH OXYGEN GASES LTD., BRIDGEWATER HOUSE, ST. JAMES'S, LONDON, S.W.1.

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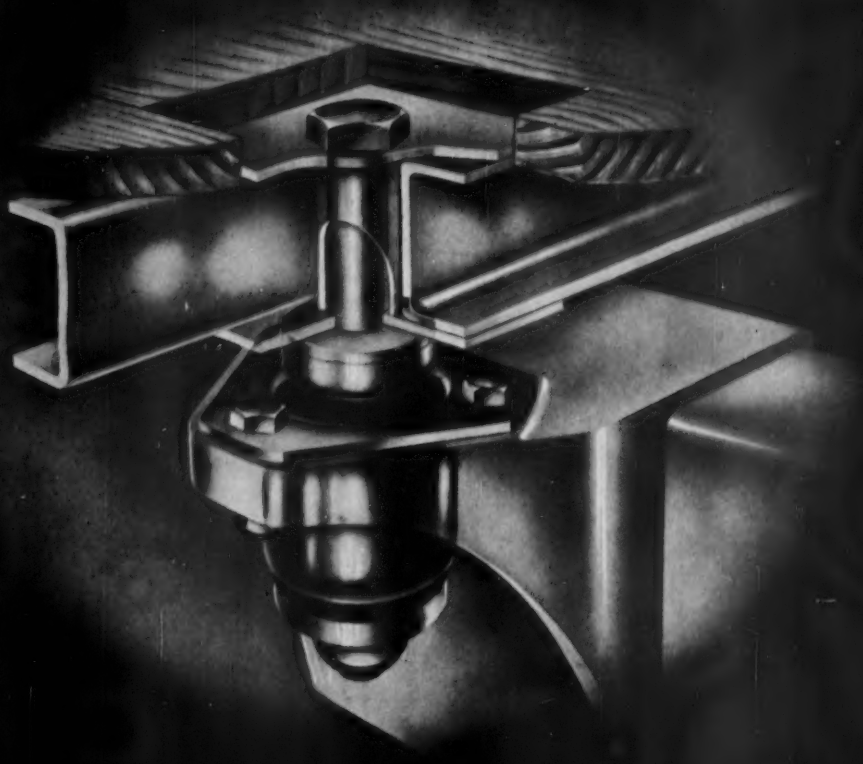

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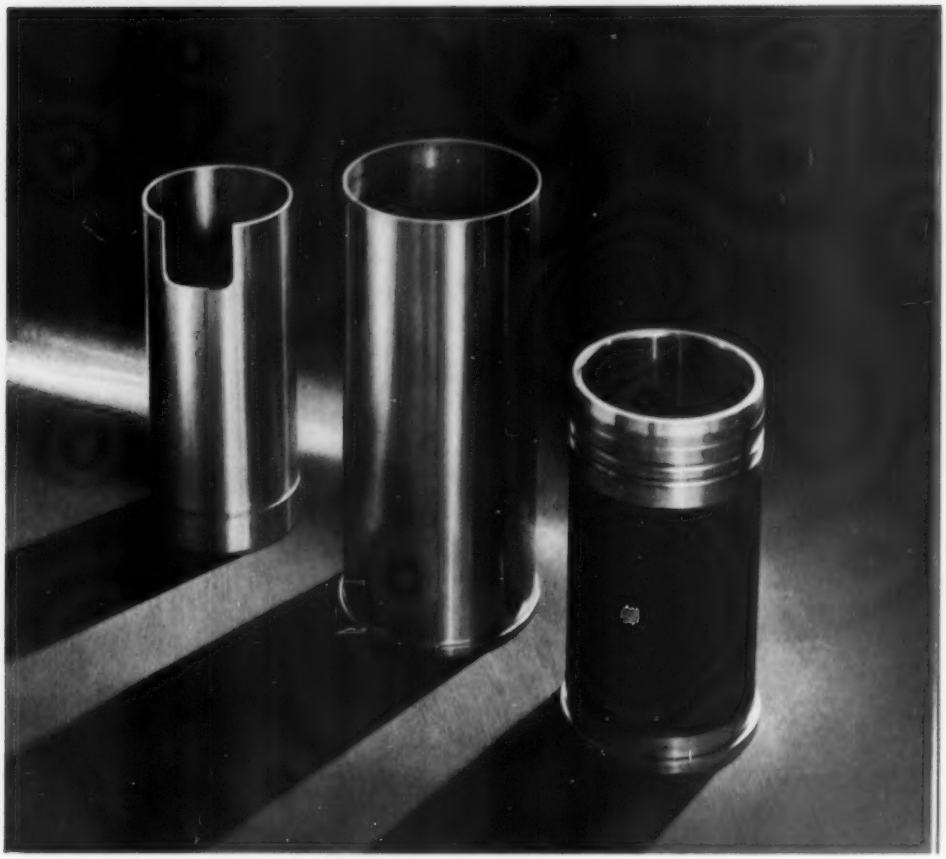

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Proved by many years' experience, our BRIVADIUM Alloy 30 Material is an accepted standard for Medium Duty Cylinder Liners.

THE BRITISH PISTON RING CO. LTD., COVENTRY **TEL. COVENTRY 89014-5-6.**

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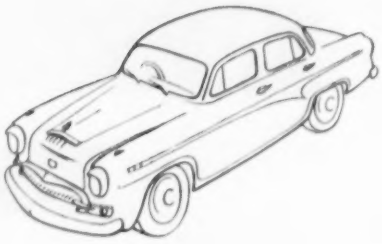
Clean

AUSTIN *use the* SPIERO PROCESS

At the Longbridge Works of the Austin Motor Company, pressed metal parts are put through a 6-tank process which renders them free from any grease, dirt or rust. The bright steel finish produced by the Spiero process also allows spot welding to be carried out. After being neutralised, the parts are treated with a de-watering fluid which protects against corrosion during assembly and/or storage periods. The Spiero process could solve your pre-treatment problems—at installation or any intermediate stage. Will you let us help? Please contact Mr. W. O. Hawkins.



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metal pre-treatment specialists

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JOHN HARPER — *over a century and a half of experience*

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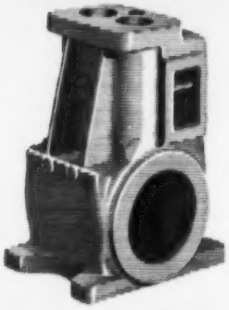
OLD IN EXPERIENCE



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MANUFACTURERS OF
HALL DOOR, RIM, MORTICE, DEAD,
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DOOR BOLTS OF EVERY DESCRIPTION,
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SOLE MANUFACTURERS OF
THE CHEAP PATENT TUMBLER PADLOCKS,
No. 940, suitable for the Levant and East Indian Markets;
PLAIN & ORNAMENTAL LIGHT CASTINGS
To any Pattern, either in Malleable or Common Iron, on the Shortest Notice.

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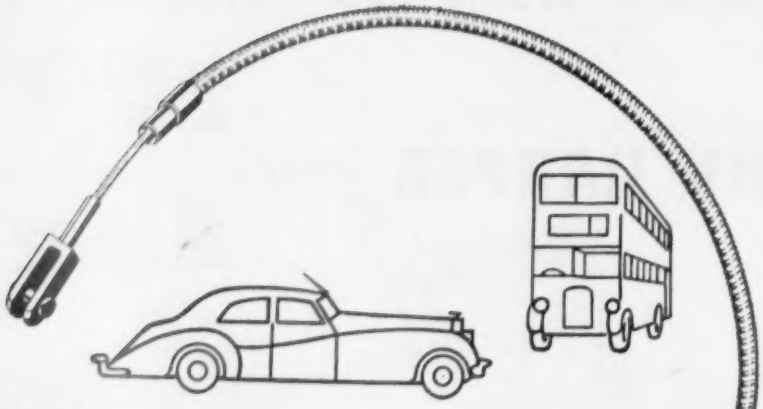

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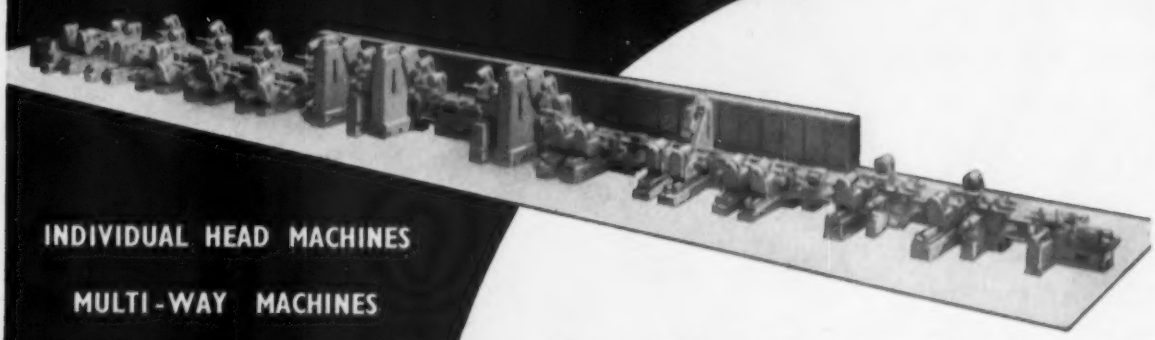
ASQUITH UNIT HEADS

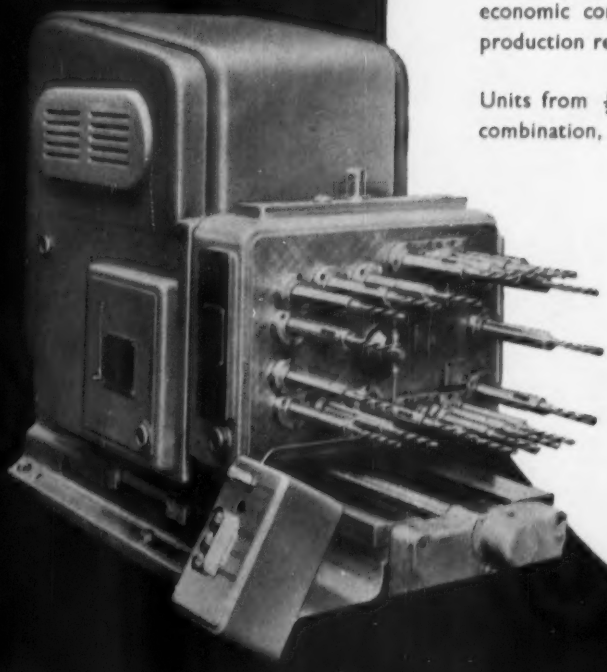


INDIVIDUAL HEAD MACHINES

MULTI-WAY MACHINES

ROTARY TABLE AUTOMATICS

IN-LINE TRANSFER MACHINES



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The Asquith range of Unit Heads provides for the adaptable and economic construction of machine tools to meet special mass production requirements.

Units from ¼ H.P. upwards can be utilized individually or in combination, and facilitate the design and manufacture of machine tools to fulfil output demands for many types of components required in large quantities. All Units are suitable for horizontal, vertical or angular mounting.

Write today for an Asquith Unit Head catalogue, or send details of the component which you visualize producing on this type of equipment.

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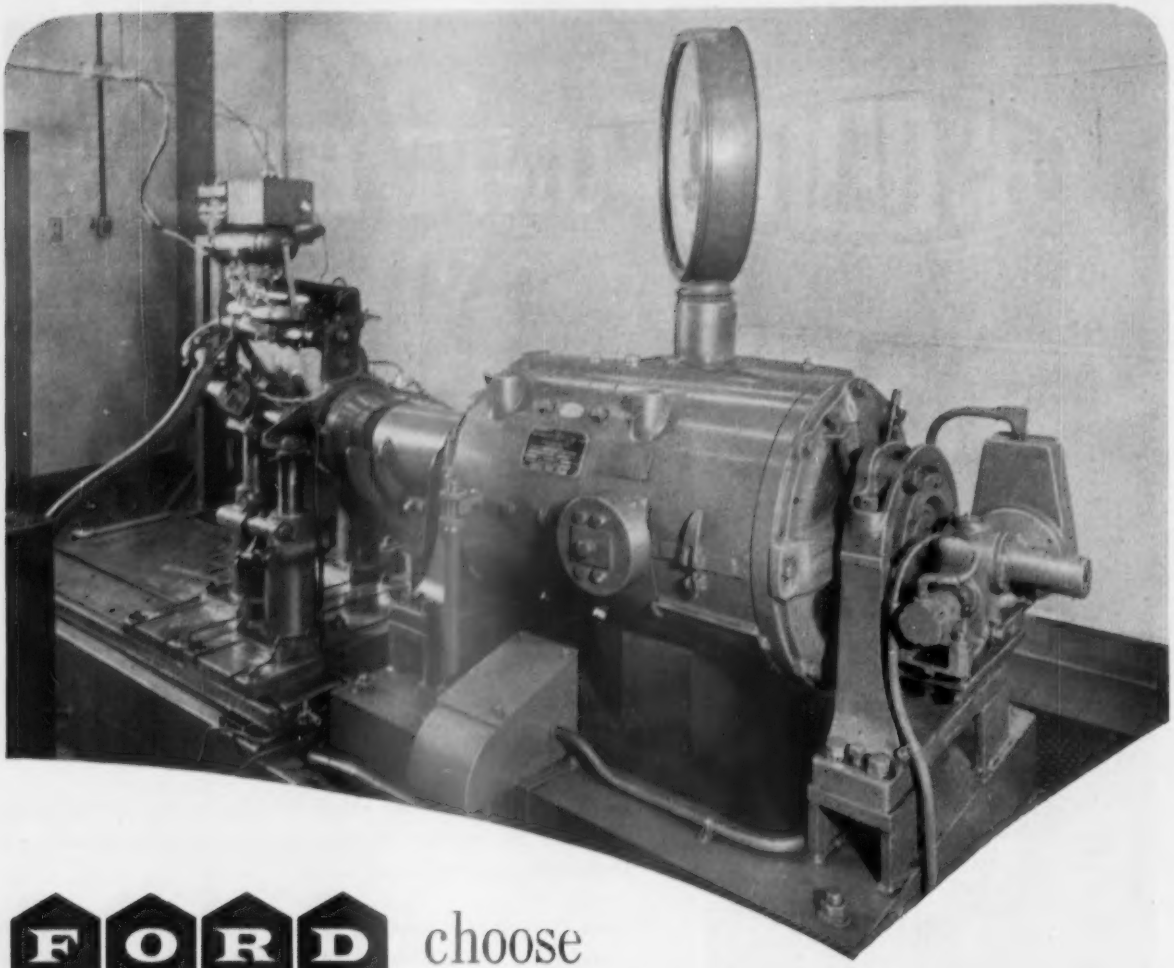

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'ENGLISH ELECTRIC'

engine test equipment

For precision in their experimental work, Ford Motor Company Ltd., at their Rainham Works have installed three 'ENGLISH ELECTRIC' 6,000 r.p.m. swinging frame D.C. dynamometers for engine testing purposes. For many years 'ENGLISH ELECTRIC' has specialised in the manufacture of this type of engine testing equipment in which the developed engine power is converted to electrical energy by the dynamometer and its attendant motor generator set and is fed back to the A.C. supply. This regenerative system in addition to avoiding the waste of engine power gives the tester precise control over the engine speed and load. The dynamometer can also be made to run as a motor at any time during a test for the measurement of hot friction losses.

for precise experimental work

THE ENGLISH ELECTRIC COMPANY LIMITED, QUEENS HOUSE, KINGSWAY, LONDON, W.C.2.
Electrical Plant Sales, Stafford.

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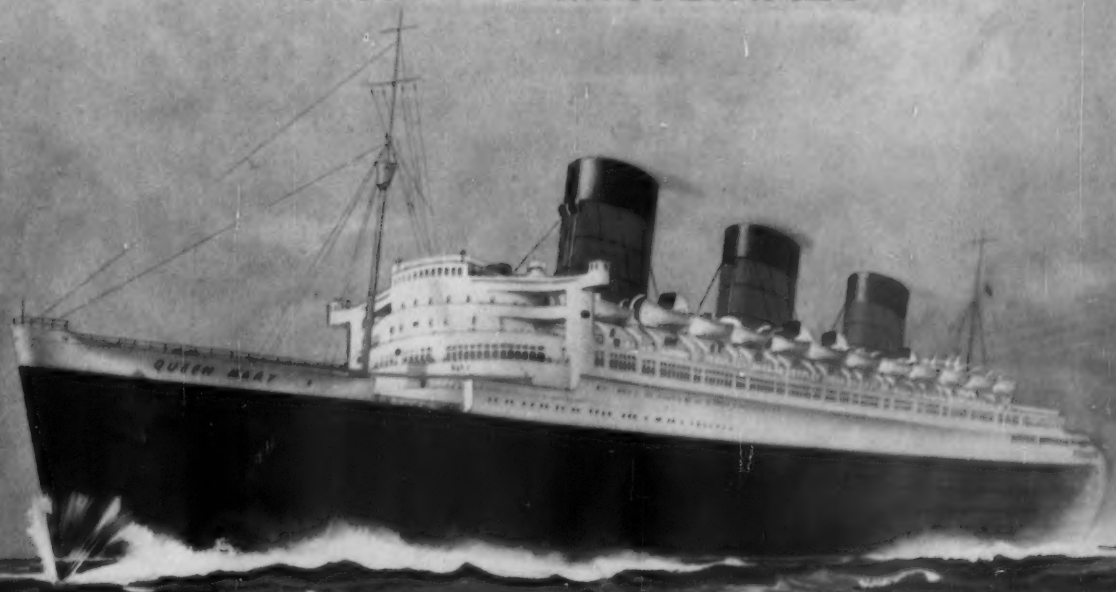

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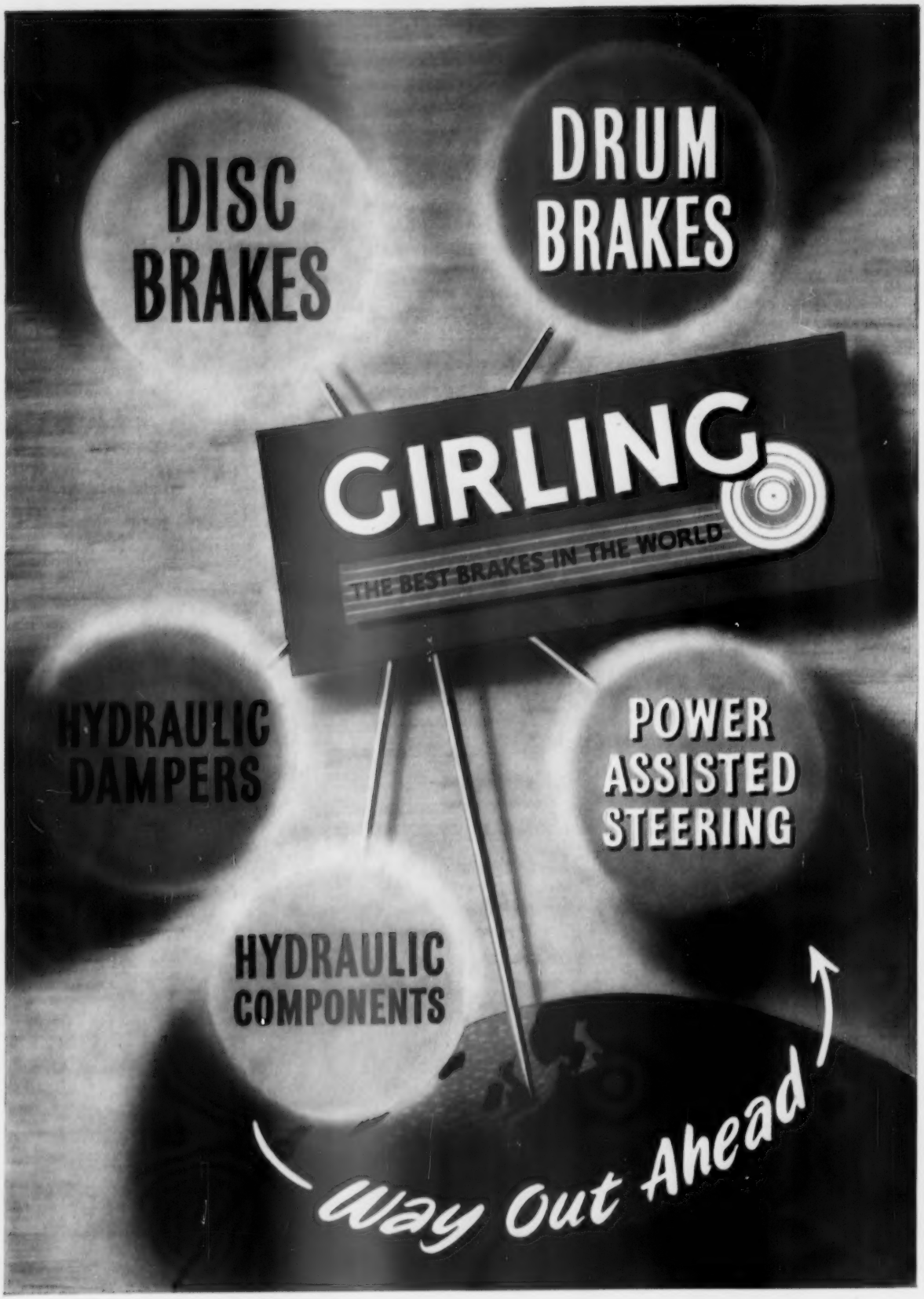

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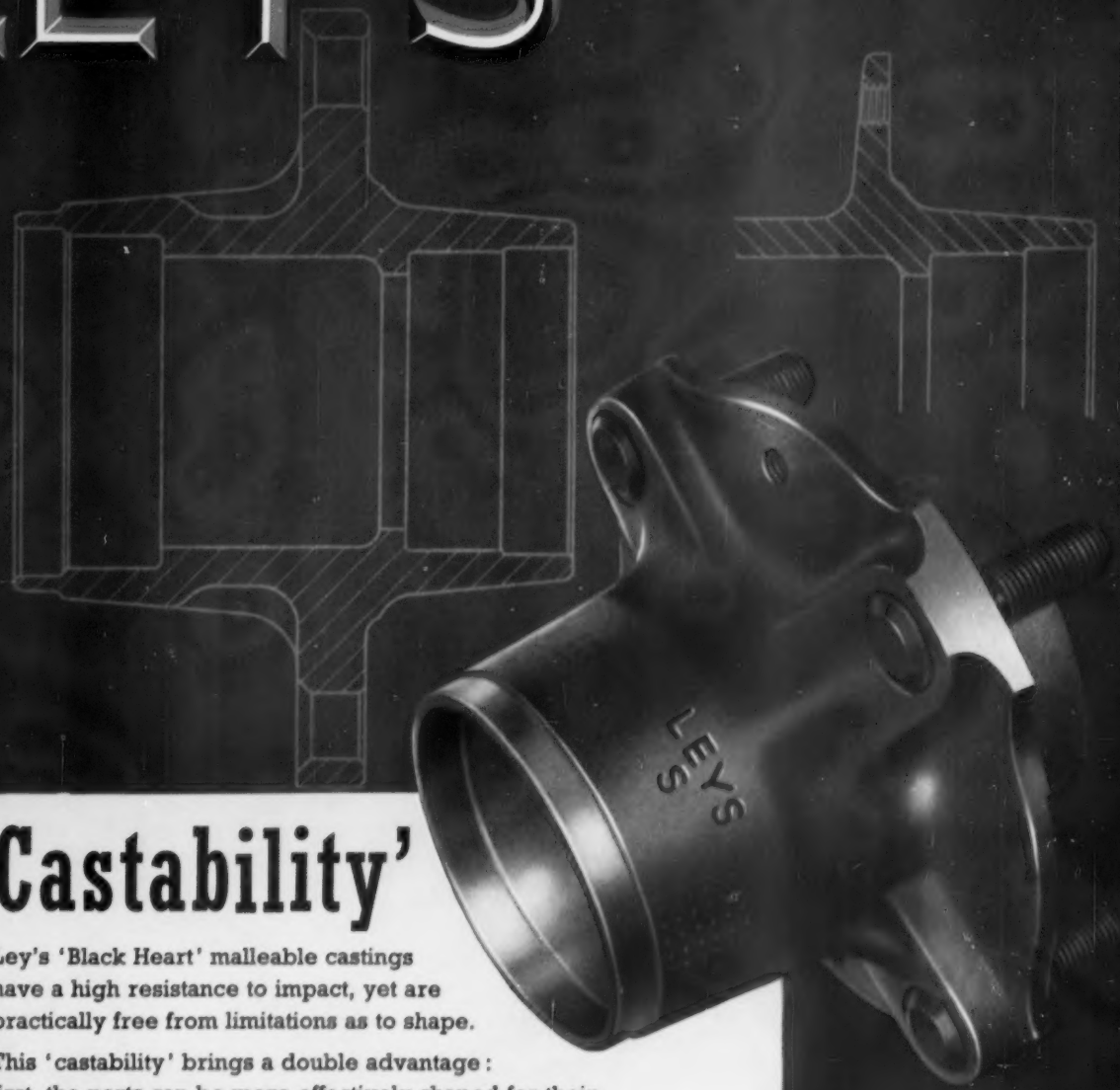
LEY'S



'Castability'

Ley's 'Black Heart' malleable castings have a high resistance to impact, yet are practically free from limitations as to shape.

This 'castability' brings a double advantage: first, the parts can be more effectively shaped for their ultimate purpose; second, this freedom from limitations generally means that less metal has to be removed.

Coupled with the easy machinability of Ley's 'Black Heart', these factors are a great manufacturing asset, moreover the finished part is better suited to its duties.

The illustrations show, actual size, the front hub of a popular car, made from Ley's 'Black Heart', completely machined.

LEY'S MALLEABLE CASTINGS CO. LTD., DERBY. TELEPHONE: DERBY 45671

STRENGTH & RIGIDITY

We offer designers the full collaboration of our engineers.

LEY'S

LANGITE

jointing material resists oils and spirits.

Used on practically every motor vehicle manufactured in this country; for more than 30 years it has also been used extensively by the electrical, oil, petroleum, aircraft and other industries.

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NEOLANGITE

A range of synthetic-rubber-bonded cork jointing materials, having the characteristic resilience of Langite but greater mechanical strength and recovery after compression. Used extensively on transformers, motor vehicles, aircraft etc.

CHINGFORD CORK 'JOINTING' MATERIAL

For less critical applications, cost may be saved by the use of this material, made alongside Langite but to a less exacting specification. All other types of non-metallic seals, compressed asbestos fibre, impregnated paper etc. can be supplied.

T.10

3,600 OPERATIONS A DAY WITHOUT BREAKDOWN!

Outstanding Performance of Atlas Copco Air Hoists at Ford's

As pioneers of mass-production, the Ford Motor Company utilises the latest developments and equipment in this field. An example of their progressive policy comes from the Ford works at Dagenham. There, for the past eighteen months, a number of *Atlas Copco* 8 cwt. air hoists, type MT 505, have been handling parts and materials in high temperatures and in atmospheres contaminated with dust and harmful chemicals.

Several Atlas Copco air hoists have been placed near the furnaces, both in the carburising plant and on the engine-block moulding line transferring the block from one conveyor belt to another. Despite the arduous conditions imposed by the furnaces, the hoists have made *3,600 journeys a day since their installation without a single breakdown or major overhaul.*

Motors completely protected

The reasons why Atlas Copco air hoists have continued to operate so efficiently under such conditions are these: the motors are totally enclosed and impervious to dust; there are no electrical insulations liable to attack by heat; the units are constantly lubricated by atomised oil entering the motors with the air stream. Because of this high degree of protection, an Atlas Copco air hoist was selected for operation above a tank containing trichlorethylene—a chemical de-greasing agent. In this application the hoist lifts metal parts requiring de-greasing into and out of the tank. The trichlorethylene fumes would soon disperse oil on the working parts of the hoist if it weren't for its unique lubrication system.

Due to their sound construction, so reducing maintenance to a minimum while operating over long periods under unfavourable conditions, Atlas Copco air hoists are contributing to increased production and efficiency at Dagenham—as they could in your works.

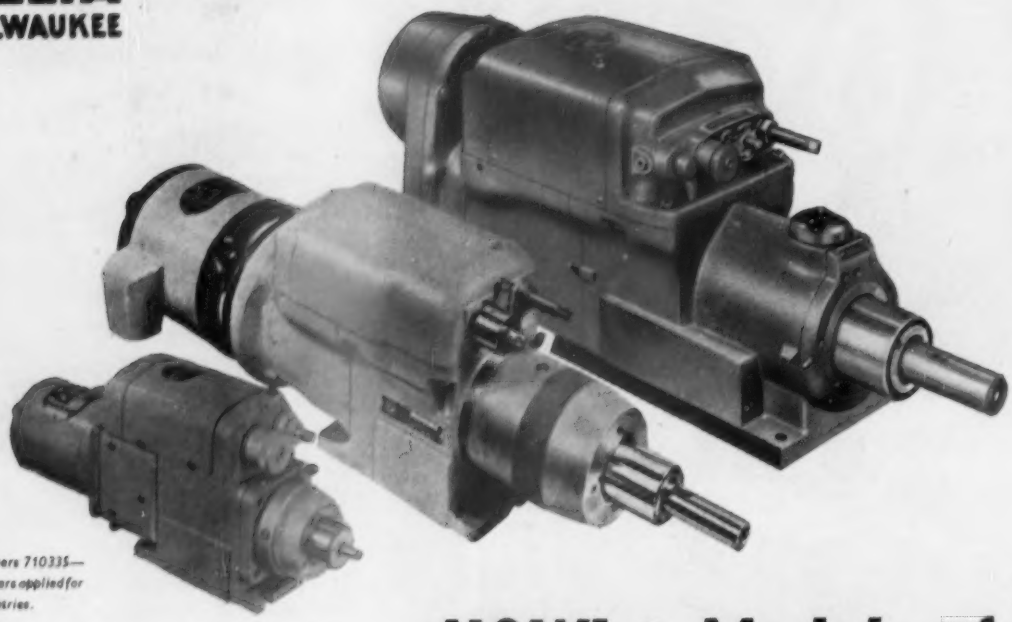
World-Wide Sales Service

The Atlas Copco Group puts compressed air to work for the world. It is the largest group of companies specialising solely in the development and manufacture of compressed air equipment. It embraces Atlas Copco companies or agents manufacturing or selling and servicing Atlas Copco equipment in ninety countries throughout the world. For further details of the equipment featured here, contact your local Atlas Copco Company or Agent. If you have any difficulty, please write to:— Atlas Copco AB, Stockholm 1, Sweden, or Atlas Copco (Great Britain) Ltd., Beresford Avenue, Wembley, Middx.

THE *Atlas Copco* GROUP OF COMPANIES

Manufacturers of Stationary and Portable Compressors, Rock-Drilling Equipment, Loaders, Pneumatic Tools and Paint-Spraying Equipment

DELTA
MILWAUKEE



Patent Numbers 710335—721848—others applied for in many countries.

NOW! 3 Models of DELTA Drill Units

AIR POWERED-HYDRAULIC CONTROL

A PRACTICAL LOW-COST WAY TO SOLVE MACHINING PROBLEMS INVOLVING DRILLING, TAPPING, REAMING, SPOT FACING, HOLLOW MILLING, CHAMFERING, CENTREING, COUNTER-SINKING AND THE LIKE—USE THE DELTA DRILL UNIT TO DEVISE SPECIAL TOOL SET-UPS THAT MULTIPLY PRODUCTION, BREAK BOTTLE-NECKS.

Rarely has a new machine achieved success so completely and so quickly as this new Delta air-powered hydraulically controlled Drill Unit.

Thousands of manufacturers, on the alert for ways to get better production faster and at least cost, have won astonishing benefits by means of this adaptable unit—by designing special machines for multiple and series operations.

YOU'LL APPRECIATE "WHY" WHEN YOU CHECK THESE 11 REASONS:

1. Quick set-up. No cams used.
2. Rapid approach and return.
3. Length of approach and total stroke positively controlled.
4. Approach repeats to within ·010 inch—final depth to within ·0005 inch.
5. Power feed hydraulically controlled . . . independent of motor and spindle speed.
6. Compressed air provides the force on a sealed, pumpless hydraulic system to move spindle forward, completely eliminating lost motion and back-lash.
7. Sealed unit construction permits operation in any position.
8. Built-in control switches.
9. Units offered as direct drive, gear drive, or pulley drive.
10. Utter simplicity of operating principle and rugged design ensure long, trouble-free service.
11. Operates efficiently at standard plant 80 p.s.i. air pressures.

Three models are now available to meet your specific requirements:

MODEL 19-150—Capacity up to $\frac{1}{16}$"—1$\frac{1}{2}$" stroke.

MODEL 19-400—Capacity up to $\frac{1}{8}$"—4" stroke.

MODEL 19-600—Capacity up to 1"—6" stroke.

FURTHER DETAILS GLADLY SENT ON REQUEST

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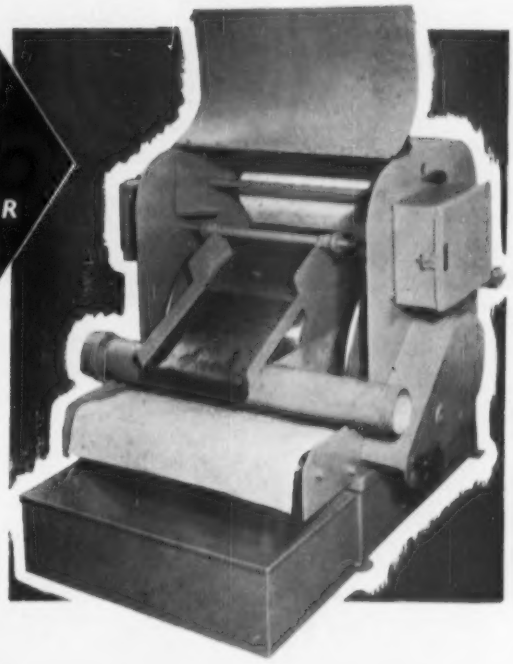
BATTERSEA, LONDON, S.W.11
PHONE BATTERSEA 8888 (8 lines)

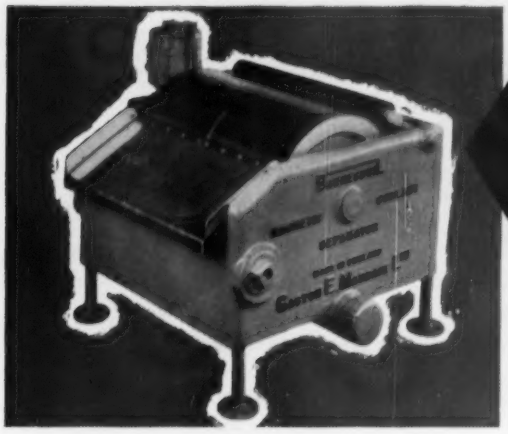
DC—35

Which one should you use ?

BARNESDRIL
KLEENALL MAGNETIC FILTER



- **Remove magnetic and non-magnetic particles from metal-cutting fluids.**
- **Economical, Automatic Operation.**
- **Rapid, Double cleaning Action.**
- **Controlled removal of non-ferrous metal.**



BARNESDRIL
AUTOMATIC-MAGNETIC COOLANT SEPARATOR

- **Permanent ALCOMAX magnets ensure infinite life.**
- **Extra long magnetic field overcomes viscosity resistance on small particles.**
- **Approximately 275 square inches of magnetic drum surface in contact with loaded coolant.**
- **Counter rotation of magnetic drum removes non-metallic particles.**

There are, of course, applications where one does a better job than the other. Since we make them both, we're completely impartial. We'd be glad to advise you which is the better solution of your problem. Write today and ask for Catalogues describing the many types and models available.

Patent Nos. 603083—731655—745604
and others applied for.

Kleenall Filters Are Plant Proven On Our Own Production Equipment

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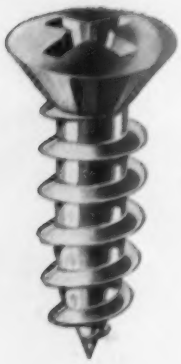
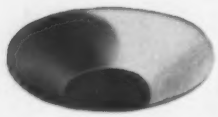


there is



a plain

advantage

With steadily-rising labour costs, every non-essential operation along the production line assumes increasing significance. One of these recurring operations has been the precision thread-cutting of screw holes, which, in assembly, have (equally precisely) to be registered together. But the tapping, self-locating screw eliminates all this, and permits assembly by less-skilled labour. And the cross-recessed head version is designed for use with power-drivers—without a scratch of damage to worker or job. The tapping screw is demonstrably quicker—cheaper—stronger—safer than the conventional machine screw. Such plain advantages pay such handsome dividends!

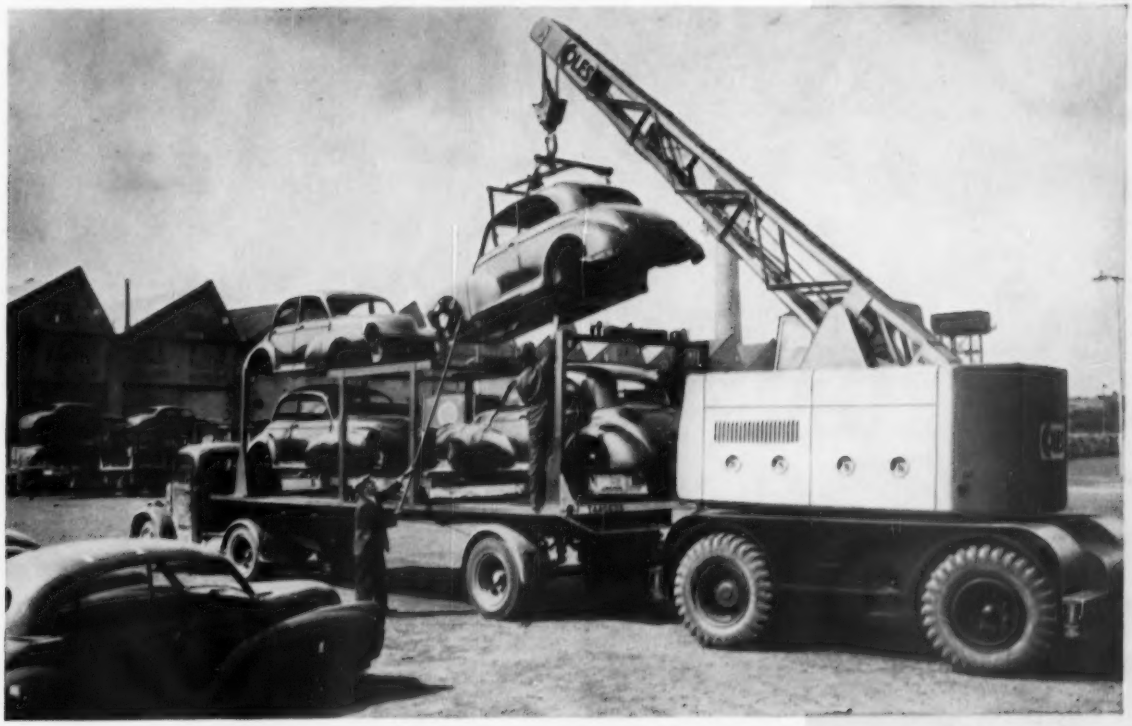
in self-tapping screws

Linread

LINREAD LTD · COX ST · BIRMINGHAM 3

Phillips slotted and recessed head machine screws and tapping screws · High tensile hexagon headbolts and setscrews
Aircraft bolts, screws and rivets · Sems · Rivnuts · Custom designed cold forged fasteners · Alex Screwplugs

Coles for that extra margin-

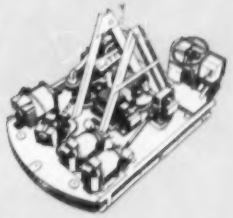


-of control and safety

Coles fatigue-free day long operation, pin-point accuracy and fast automatically safe motions, perform an unrivalled role in the automobile industry

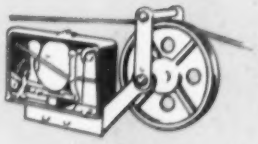
Essential for double-tier loading, Coles high angle cantilever jib and *Electric Transmission* system provide that extra margin of lift and safety with an instant choice of rapid or slow precise creeping speeds for lifting, derricking and slewing.

Always on hand to solve the numerous lifting problems that crop up in any factory, Coles have many saving ways.



ELECTRIC TRANSMISSION

Coles have cleared the decks - no inaccessible spots here. Individually powered electric motors provide smooth sustained power for all motions.



SAFE LOAD INDICATOR

Warns visually and audibly when maximum load is reached in any jib position, and positively cuts the motion if the warning is ignored

COLES

THE NAME THAT CARRIES WEIGHT

Designed, manufactured and marketed by:-

STEELS ENGINEERING PRODUCTS LIMITED

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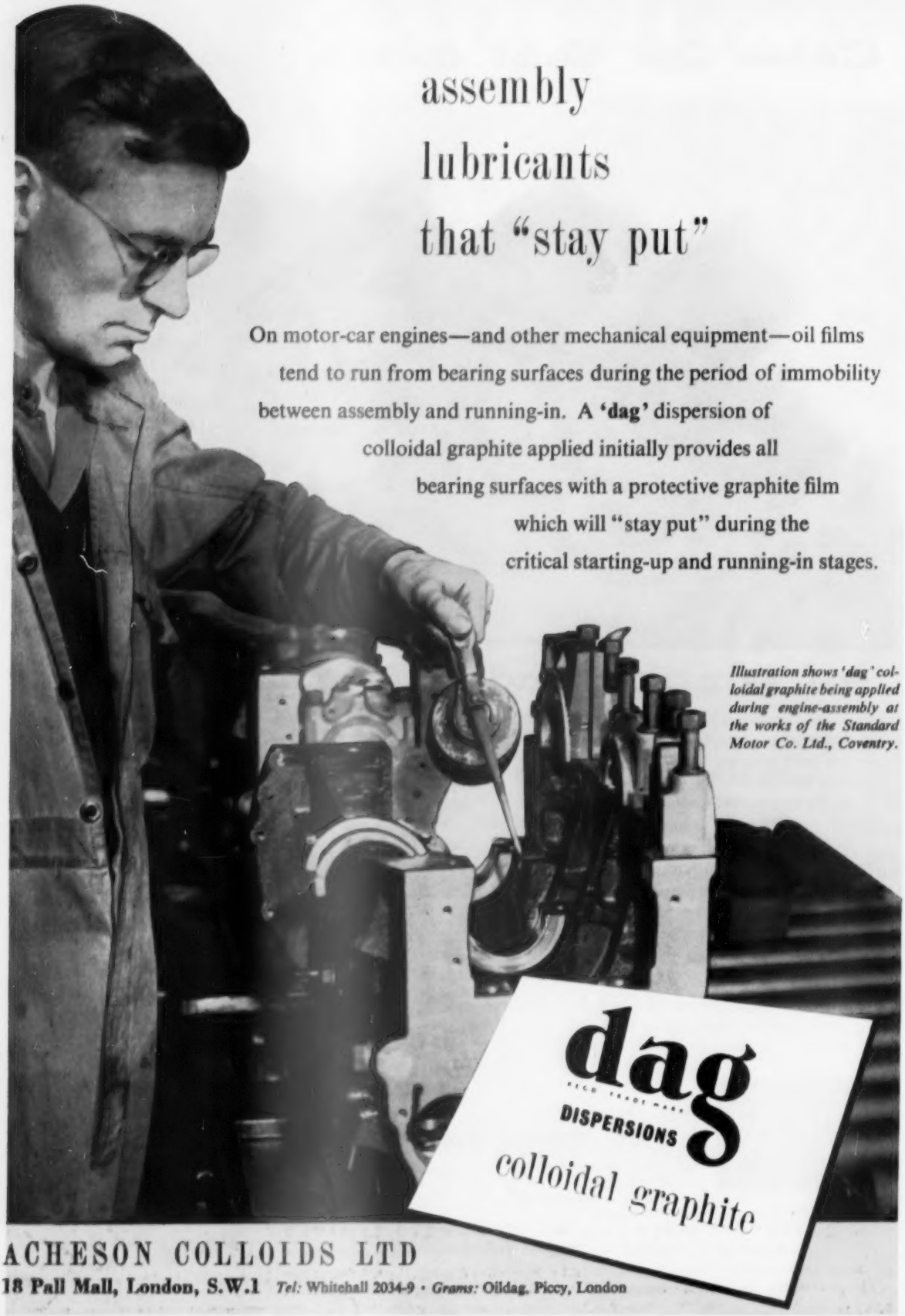

assembly lubricants that "stay put"

On motor-car engines—and other mechanical equipment—oil films tend to run from bearing surfaces during the period of immobility between assembly and running-in. A **'dag'** dispersion of colloidal graphite applied initially provides all bearing surfaces with a protective graphite film which will "stay put" during the critical starting-up and running-in stages.

Illustration shows 'dag' colloidal graphite being applied during engine-assembly at the works of the Standard Motor Co. Ltd., Coventry.

dag
DISPERSIONS
colloidal graphite

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SHAFT MOUNTED GEAR UNITS

8 SIZES of SINGLE REDUCTION GEARS — POWERS up to 110 h.p. OUTPUT SPEEDS from 100 to 425 r.p.m. when used with CROFTS SUPROR SURE-GRIP V-ROPE DRIVES.

8 SIZES of DOUBLE REDUCTION GEARS — POWERS up to 70 h.p. OUTPUT SPEEDS from 8 to 125 r.p.m. when used with CROFTS SUPROR SURE-GRIP V-ROPE DRIVES.

Used in combination with other standard Crofts products, a much wider range of torques and speeds (including infinite variation) is possible.

A development of our live shaft floating drive which has proved highly successful for over ten years.

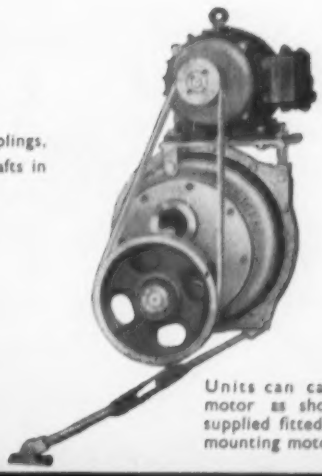
SIMPLE MOUNTING direct on to the machine shaft, whatever the angle, eliminates couplings, baseplates and foundations. This makes an ideal drive for vertical or inclined agitator shafts in chemical and food processing machinery, as well as for any horizontal application.

INTERCHANGEABLE BUSHES facilitate fitting on a wide range of shaft diameters.

DIFFERENT SPEEDS easily obtained using quick-change Crofts Taper-Flushbush pulleys.

BELT TENSION simply adjusted by the torque reaction bar.

WRITE FOR PUBLICATION No. 655/1.



Units can carry driving motor as shown, or be supplied fitted with flange mounting motor.

Crofts (ENGINEERS) LIMITED. BRADFORD 3. ENGLAND

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ALUMINIUM BRONZE CO. LTD.

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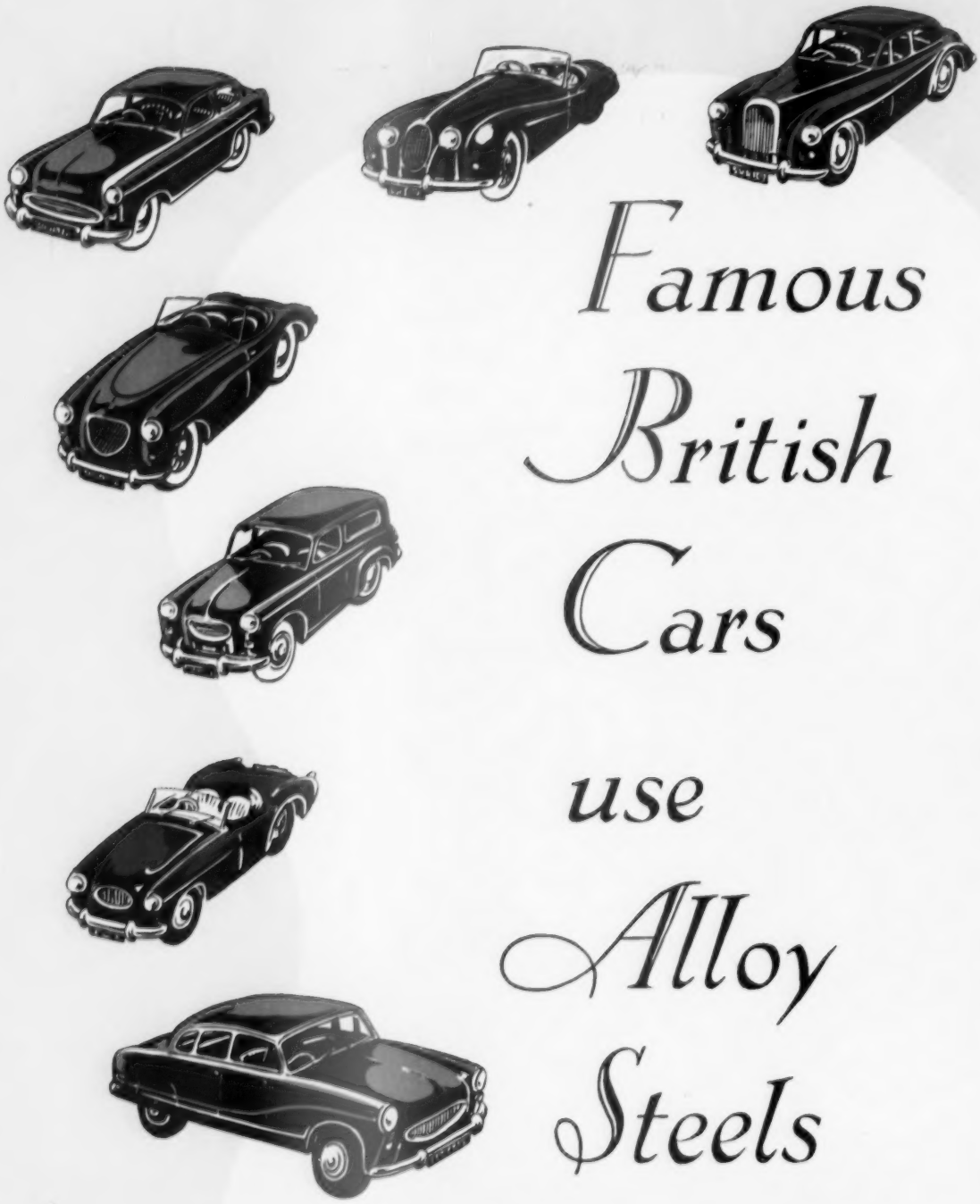

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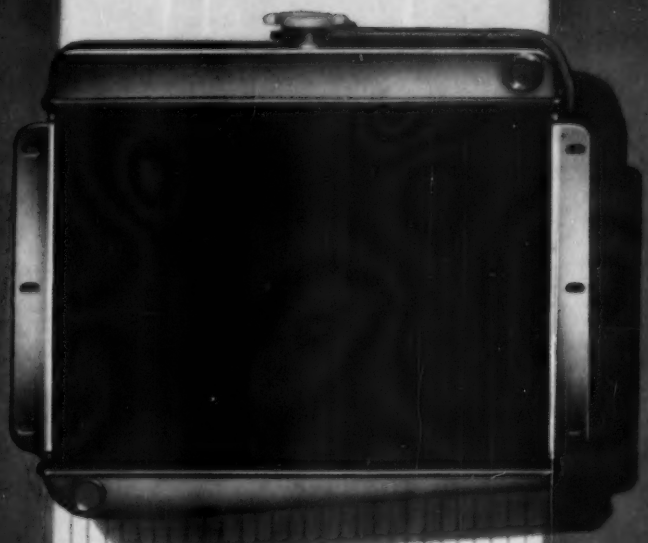

the Radiator design can be safely left to

CMF

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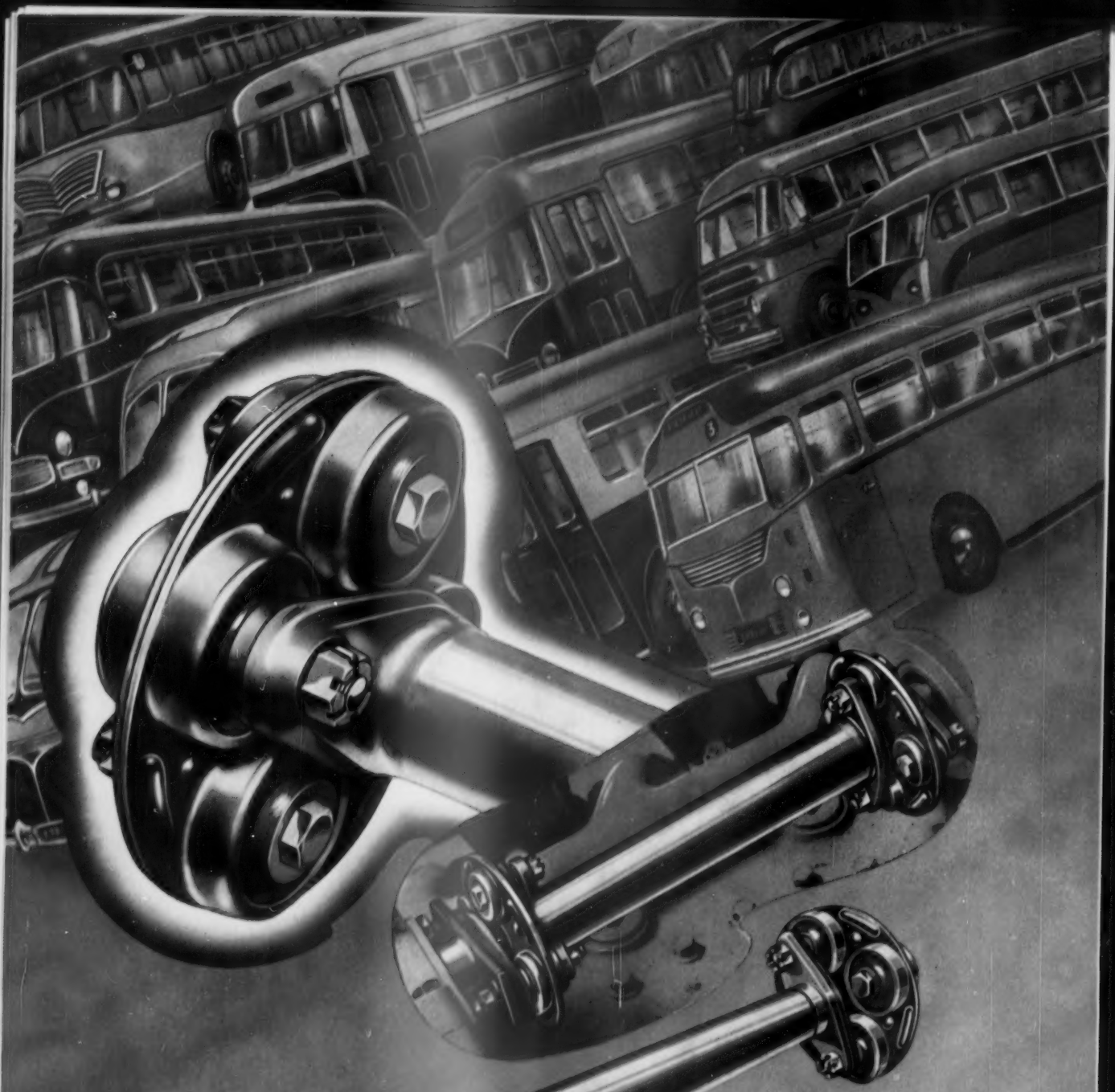

No matter how high the power or how high the R.P.M; Layrub transmission is supreme. It is widely used on Commercial and Passenger vehicles, Diesel Railcars, Tractors, Cars, etc; and a special coupling has been developed to cope with the very high speeds of jet engines. Owing to the use of rubber trunnion blocks as the main driving elements, Layrub gives a true cushioned drive, and with the absence of metal-to-metal contacts, lubrication is not required. Here then is a transmission system designed for modern times—a drive shaft that can be installed and almost forgotten. If you would like to know the full capabilities of these shafts contact us at the address below.

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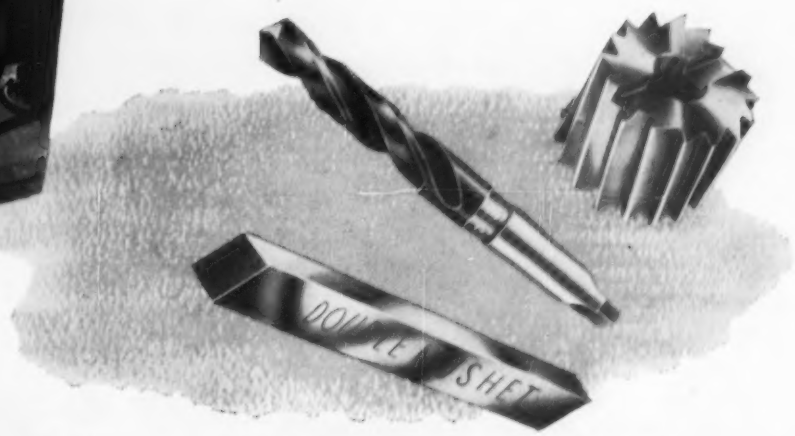

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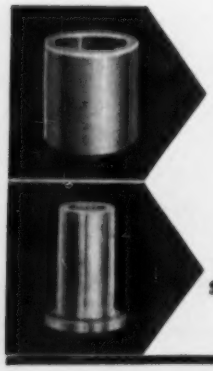
Increase output by simplifying your own machining programmes. For instance, use Compo and Powdiron Bearings, which are made by the powder metallurgy process to such close tolerances that they are ready for immediate installation. A simple press fit is obtained without reaming or machining, and their self-lubricating properties eliminate the need for oil holes — another saving in drilling time. Specify Compo and Powdiron and have bearings ready to fit accurately, simply and economically. Standard cylindrical bushes are available from stock in a wide range of sizes.



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Higher efficiency
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ALL-AIR RANGE SHIFT CONTROL ON LATEST ROADRANGERS

Multi-speed transmissions with two operating levers have always proved a headache to the drivers owing to the difficulty and delays of making some of the changes.

In their ROADRANGER series, Fuller have completely solved this by providing single lever control, the shifts in the two-speed box in tandem with the main box being air operated. All range shifting, up or down, is actuated by a selector handle, at the driver's fingertips, on the gear shift lever. Range shifts are pre-selected, automatic and synchronised.

Fuller heavy-duty ROADRANGER boxes are now available in three types, the R-46 (as illustrated) for engines of 460 cu. in. provides 8 forward speeds; the R-96/R-960 series for engines of 960 cu. in. provides 10 forward speeds; the R-1150 for engines of 1150 cu. in. provides 9 forward speeds.

Exclusive European Representatives for the Fuller Manufacturing Company of Kalamazoo, Michigan, U.S.A.

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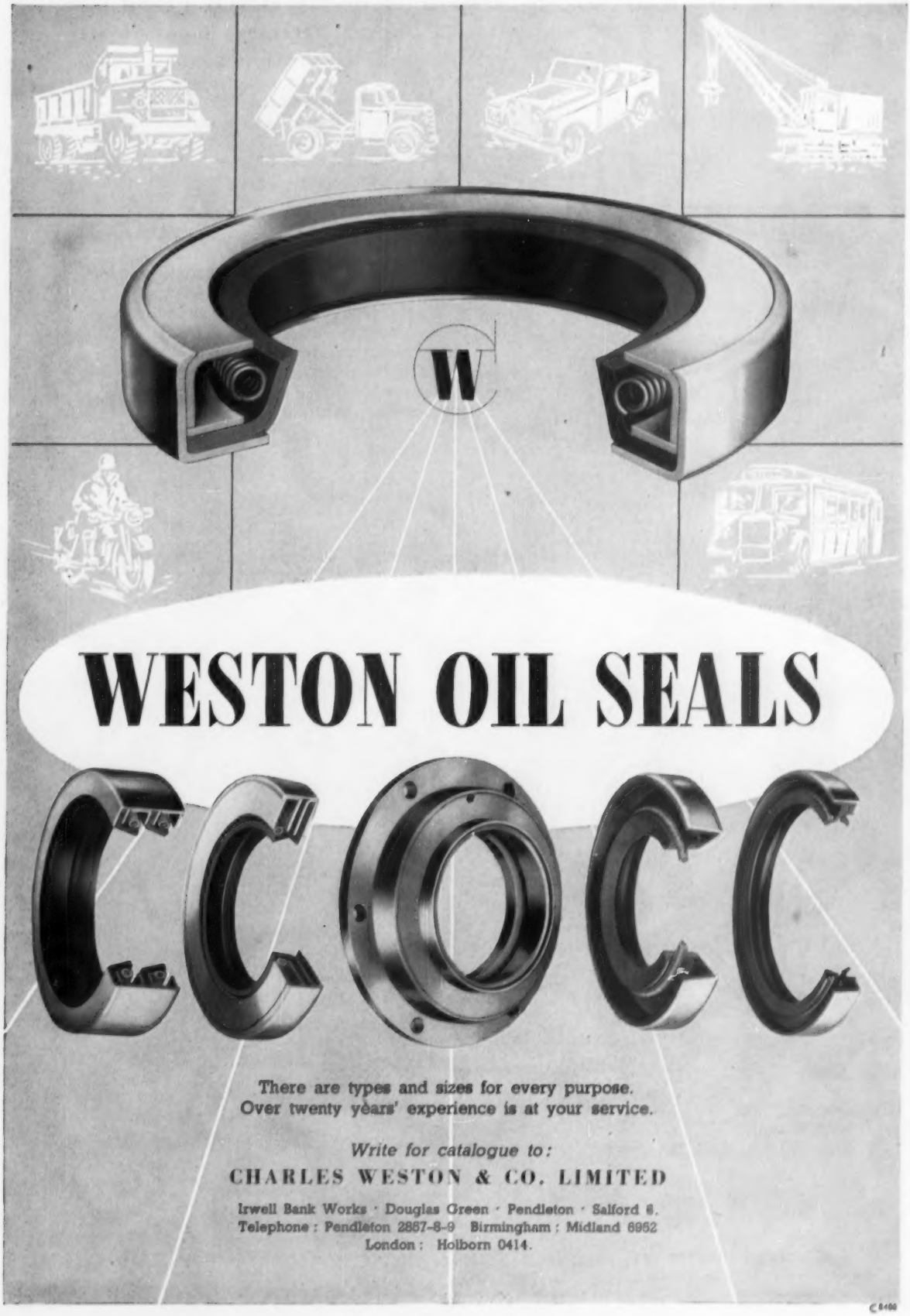

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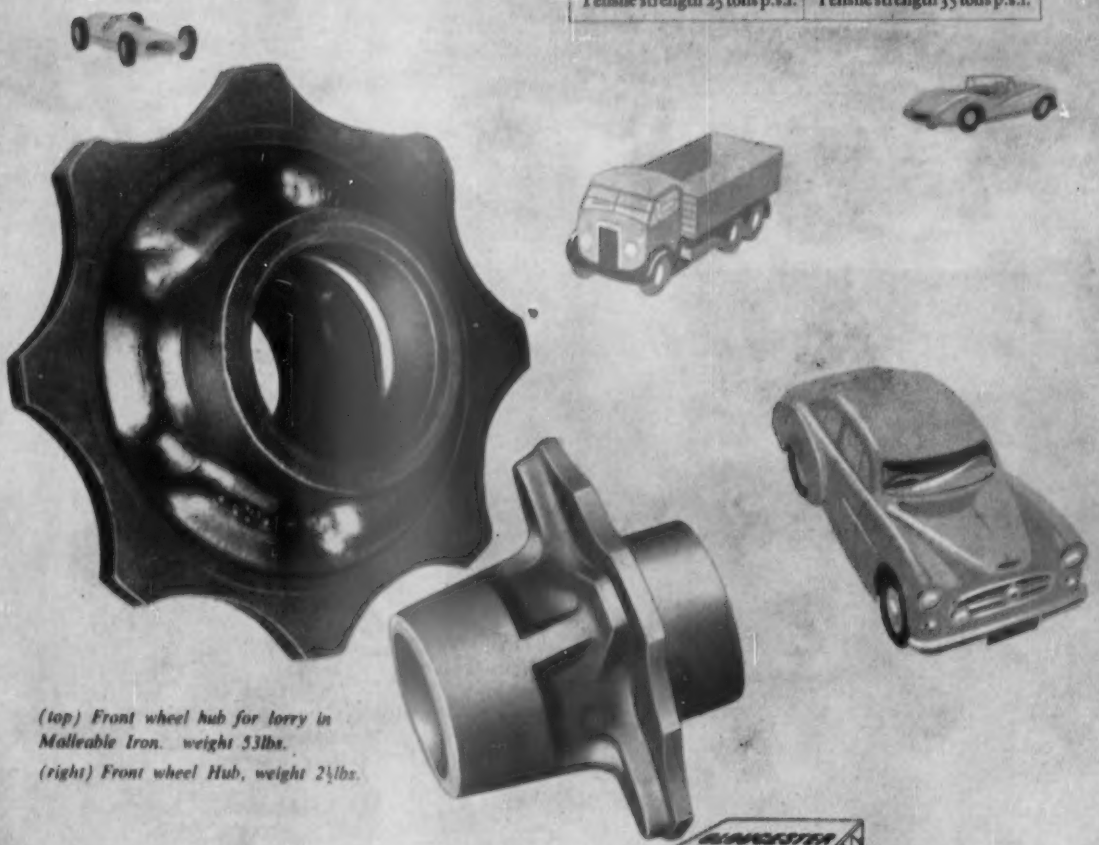
Always consult Gloucester at the designing stage – even before – their experience and resources are placed unreservedly at your disposal.

The following are typical Gloucester Malleable specifications.

Gloucester Blackheart Malleable		*Gloucester Lamellar Pearlitic Malleable*	
Elongation	18%	Elongation	5%
Yield Point	15 tons	Yield Point	22 tons
Tensile strength	25 tons p.s.i.	Tensile strength	35 tons p.s.i.



(top) Front wheel hub for lorry in Malleable Iron. weight 53lbs.
(right) Front wheel Hub, weight 2¼lbs.

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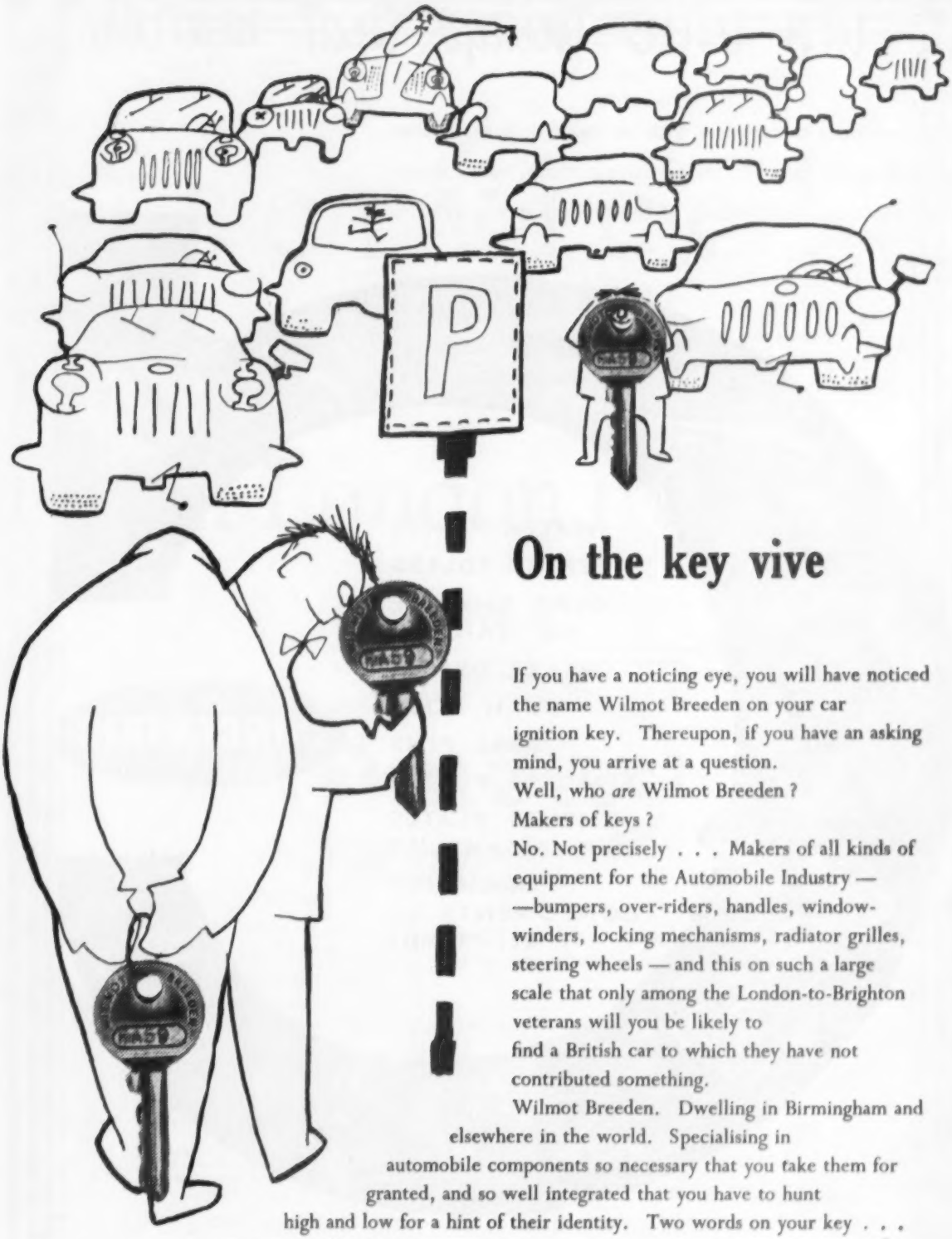

On the key vive

If you have a noticing eye, you will have noticed the name Wilmot Breeden on your car ignition key. Thereupon, if you have an asking mind, you arrive at a question.

Well, who *are* Wilmot Breeden ?

Makers of keys ?

No. Not precisely . . . Makers of all kinds of equipment for the Automobile Industry — —bumpers, over-riders, handles, window-winders, locking mechanisms, radiator grilles, steering wheels — and this on such a large scale that only among the London-to-Brighton veterans will you be likely to find a British car to which they have not contributed something.

Wilmot Breeden. Dwelling in Birmingham and elsewhere in the world. Specialising in automobile components so necessary that you take them for granted, and so well integrated that you have to hunt high and low for a hint of their identity. Two words on your key . . . many parts of your car . . .

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If any of your requirements are in the nature of NON STANDARD or SPECIAL ITEMS to your own particular details contact us if you require assistance, our wide knowledge and experience as SPECIALISTS is at your service.

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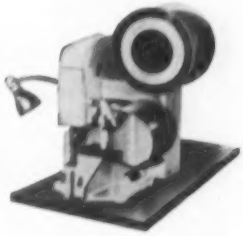
Certi-crimp hand tool. Positive closure ensured.

Pneumatic hand tool eliminates operator fatigue.



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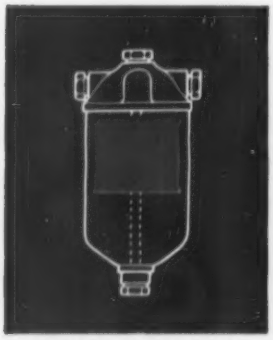
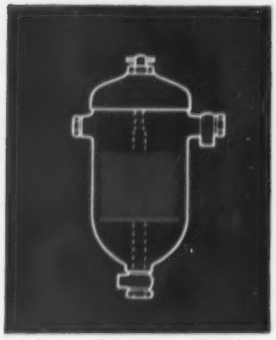
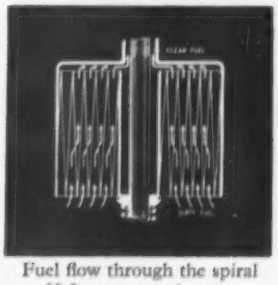
Save on diesel maintenance with this modern paper fuel filter



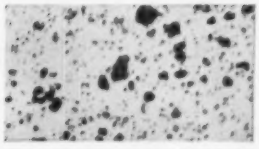
Cross-flow filter refitted with paper element.



Down-flow filter refitted with paper element.



Fuel flow through the spiral V-form paper element.



(a) Photomicrograph of fuel (x100) as supplied.

(b) Photomicrograph of fuel (x100) after filtering with the new element.

This new filter, tested under the most stringent service conditions, has increased the life of fuel injection equipment to which it has been fitted up to eight times that obtained with ordinary filters. This is because it is extremely efficient in removing the finest abrasive dust particles and thus in stopping wear. Now it is available for fitting to your existing C.A.V. cloth or felt filters types BFA11P, BFA11S, BFA11PS and BF11BS. Simple, inexpensive conversion kits are available, and the standard type of paper element is used for all. Consult your C.A.V. Service Agent—the conversion can save you money and the life of your equipment will be prolonged.

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The steadily increasing acceptance of the LAYCOCK de Normanville OVERDRIVE by manufacturers and public alike is a tribute to ALL-BRITISH design and engineering skill. The inclusion of the LAYCOCK OVERDRIVE in the specification of a car is both an assurance and promise of high performance and peak engine efficiency.

LAYCOCK ENGINEERING LIMITED · SHEFFIELD

Enquiries to: Laycock Engineering Limited, Overdrive and Transmission Sales Division, 16/17 Hertford Street, Coventry. Under exclusive licence from Auto Transmissions Ltd., Coventry. Electrical controls by Joseph Lucas (Electrical) Ltd.

Sports car body moulded by Martin Plastics Ltd., from "Duraglas" glass fabric bonded with "Bakelite" polyester resins.

The key to better plastics reinforcement

DURAGLAS

REGISTERED TRADE MARK

You can keep down the weight—and the cost—yet keep up the strength with "Duraglas" glass fibre reinforcements for constructional plastics. "Duraglas" can be used wherever a combination of lightness with strength and durability is desirable. Both the sports car and the van illustrated are fine examples of the use of plastics in modern bodybuilding, employing "Duraglas" glass fibre reinforcement. We shall be glad to supply further details and samples.

Standard Bedford Van fitted with one-piece "Duraglas" plastic roof panel by R. W. Osborne & Son.

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The Universal Dampers Organisation is the only concern in the United Kingdom devoted entirely to the production of the damper. The results of this concentration of energies are Rotoflo and Telaflo; no other dampers in the world have an equivalent background of single-minded development. No other dampers in the world have achieved the same standard of technical efficiency.

ROTOFLO ROTARY TYPE non-friction dampers operating on the unique Pressure Flow principle, exceptionally reliable, virtually attention free, low in initial cost and *adjustable.*

TELAFLO the current peak in telescopic damper design; tough and untemperamental, built to tackle the roughest going and to give the smoothest ride. Available in variations of end-fitting and setting for almost every vehicle using direct-acting dampers.

TELAFLO ADJUSTABLE Dampers chosen to provide instant ride-control at all speeds and under all conditions from the driver's seat of the special equipment Armstrong Siddeley Sapphire 346. The first dampers of their kind to go into normal production. Shortly to be available for other makes of car.

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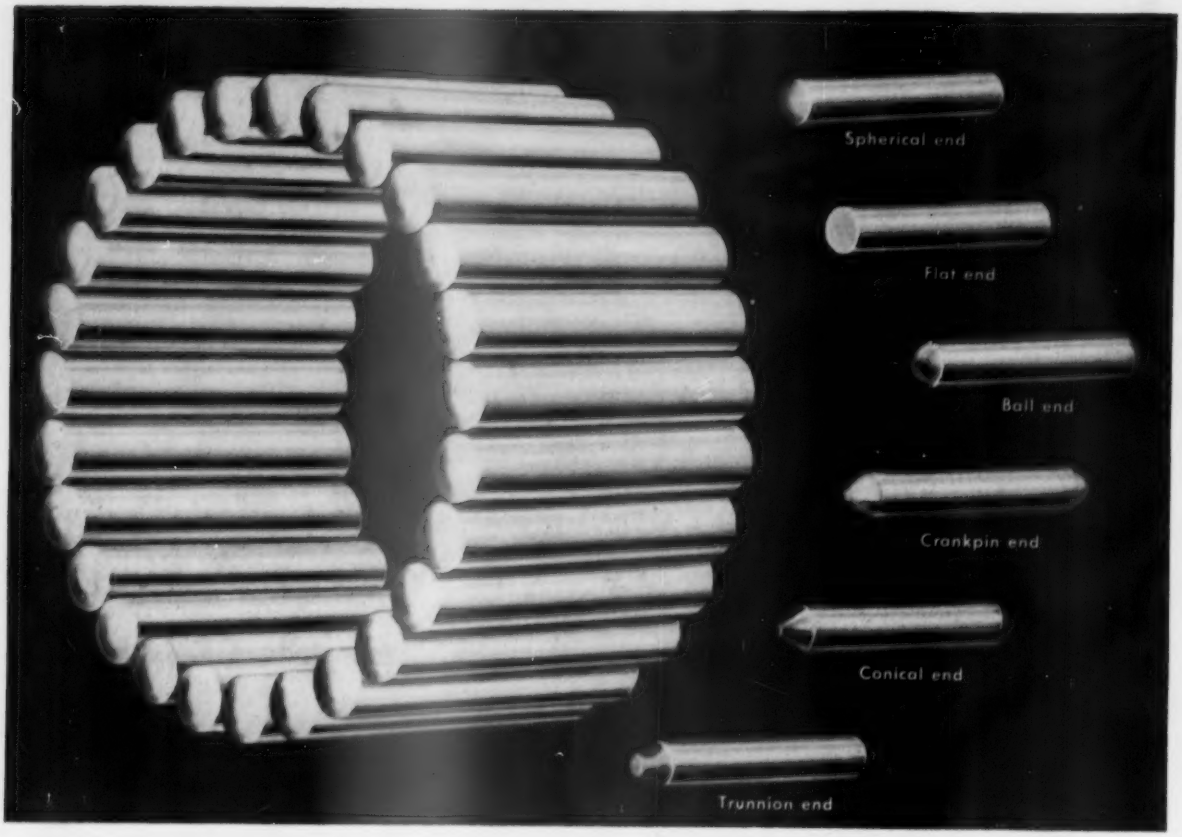
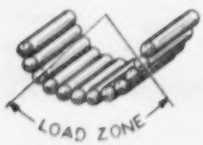
TORRINGTON NEEDLE ROLLERS

for the ultimate in load capacity at low cost

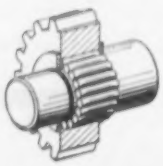


High radial capacity in minimum space is provided by full complement of small-diameter rollers. Load zone contains maximum number of contact lines.



High carbon chrome steel is carefully hardened, ground and lapped to make each Needle Roller a precision part for long-life performance.

Close tolerances on Needle Rollers are assured by stringent quality controls. Standard OD tolerance is .0002". Tolerance on length dimension depends on end formation.



Mounted without races between hardened shaft and hardened housing (RC-60 recommended), Needle Rollers allow largest possible shaft diameters.

Fine finish contributes to efficient anti-friction performance. Needle Rollers are usually polished to 4-6 rms finish.

Good operating results with Needle Rollers require careful design of mating parts furnished by the user.

Our Bearings Division with broad experience in applications of Needle Rollers will be glad to give you technical advice on your needs.

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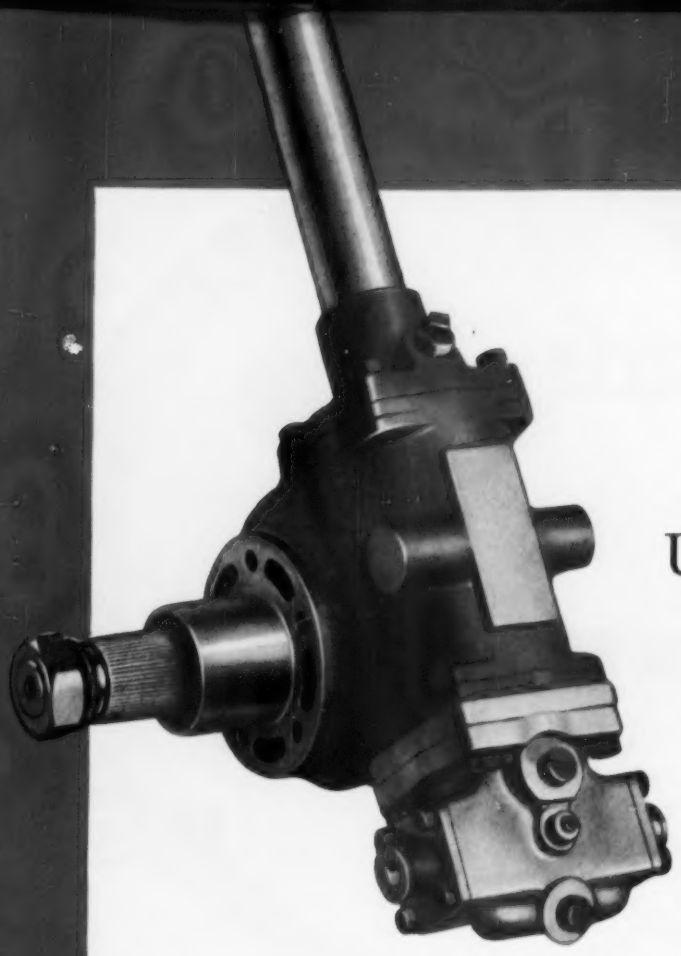
TORRINGTON NEEDLE BEARINGS

NOW AVAILABLE FROM OUR ENGLISH FACTORY



THE UNIVERSAL UNIT

In a previous advertisement we showed the Marles patent 'Integral' type power assisted steering unit, in which a cam and double-roller steering gear, the valves, cylinders and pistons are included. We now illustrate above the 'Universal' steering gear which incorporates the hydraulic control valves mounted upon our type '861' manual gear. This is for use with a separate power pump and with power cylinders operating on the steering linkage.

ADAMANT ENGINEERING CO. LTD., DALLOW ROAD, LUTON

Sole proprietors of the Marles Steering Company Ltd.

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of leadership
entails responsibility,
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they may rightly
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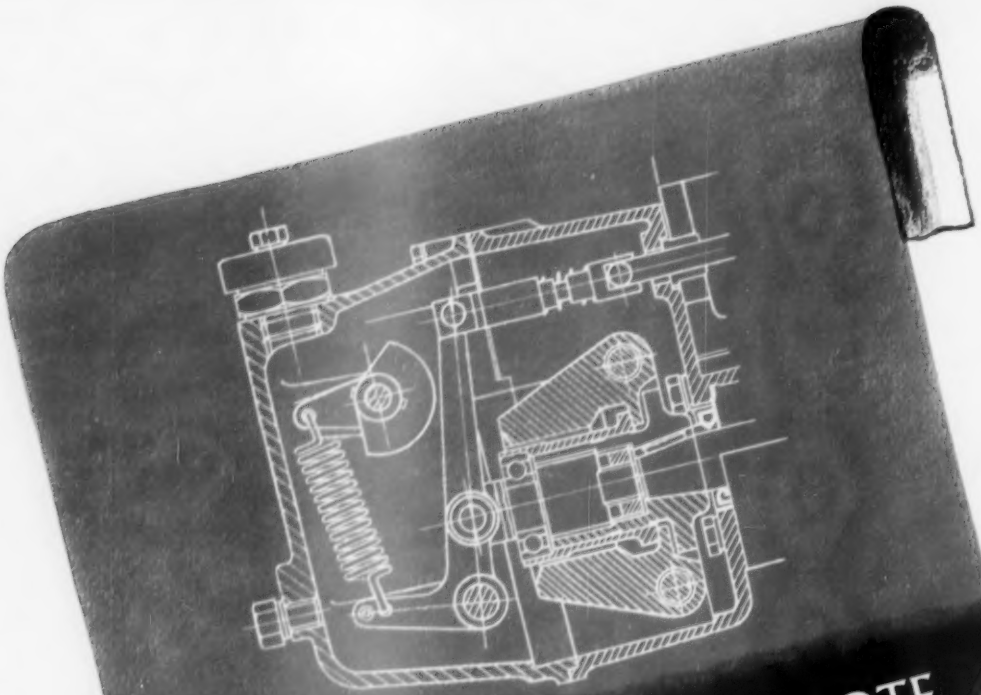

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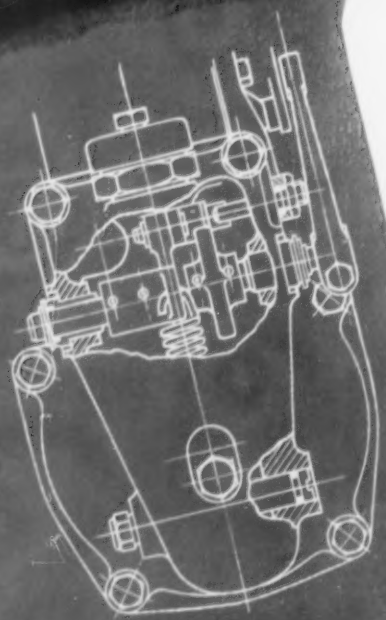

A sectional view of the Simms Centrifugal Governor — type GM.

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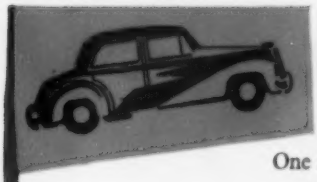

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TEXOLEX IN THE AUTOMOBILE INDUSTRY

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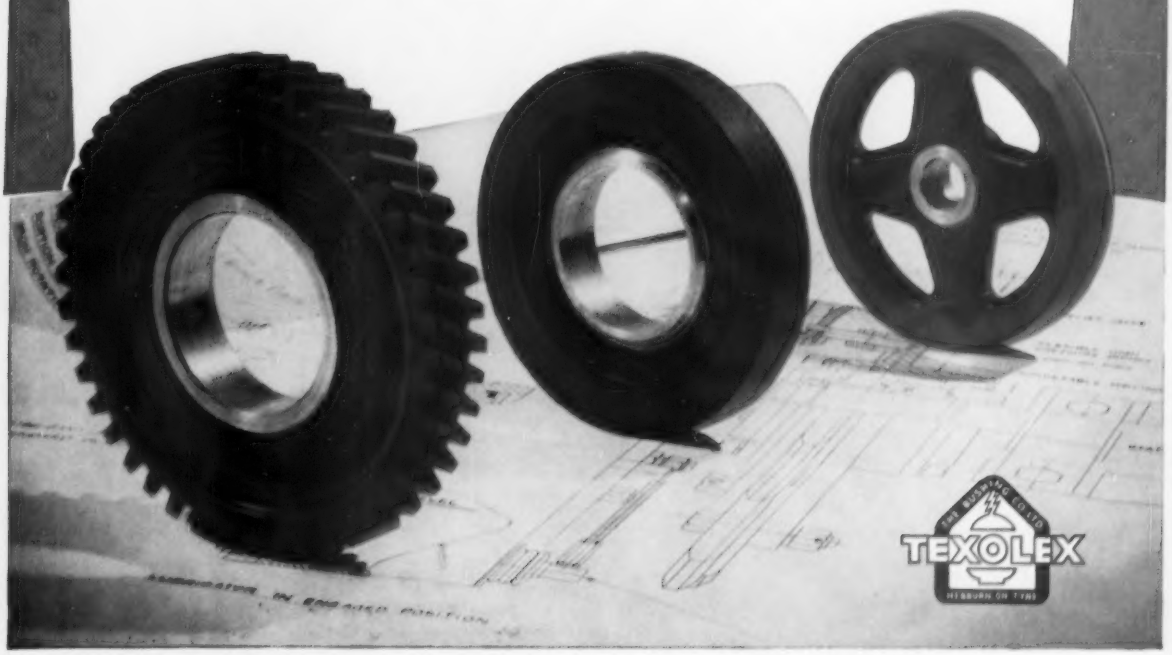

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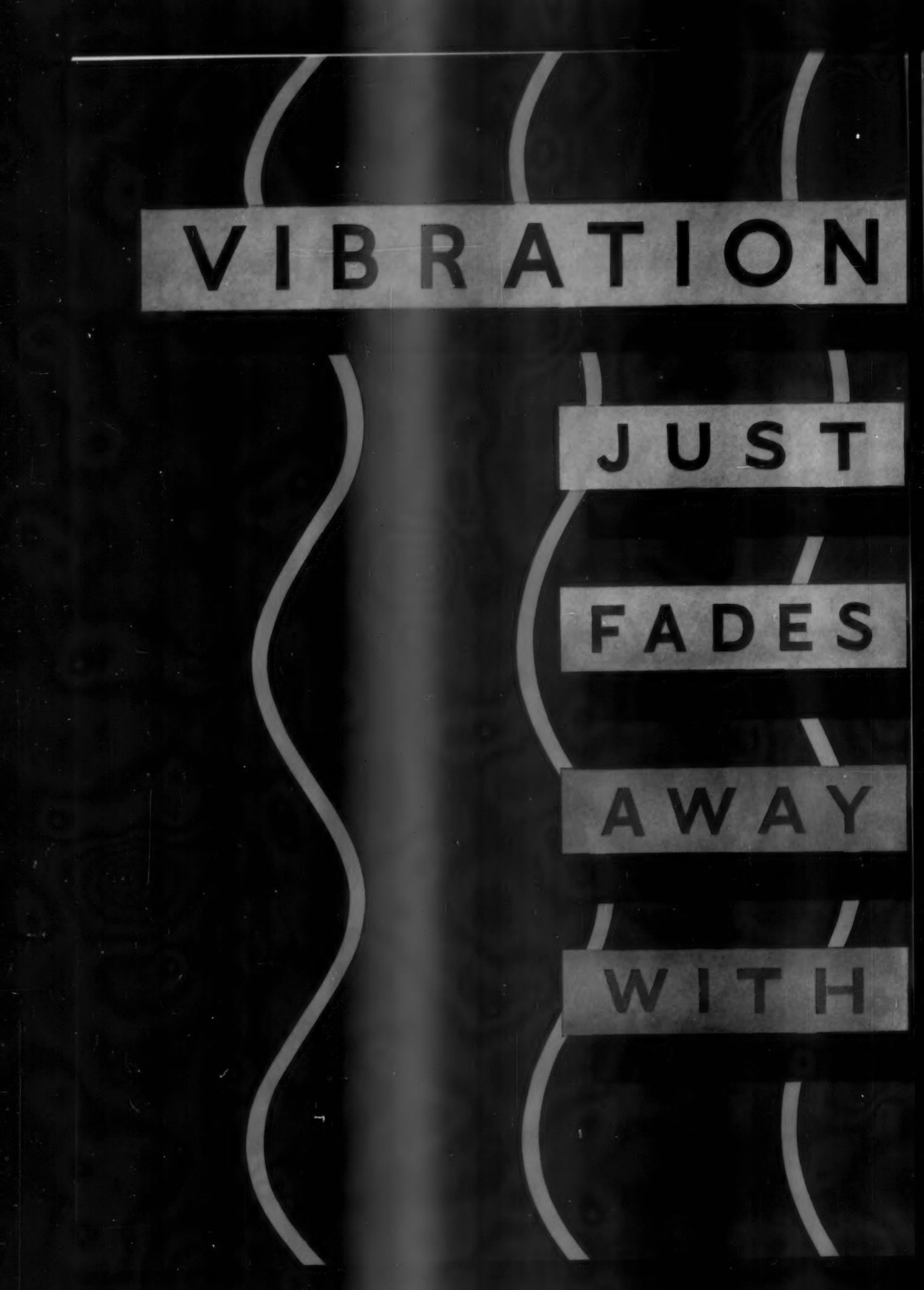
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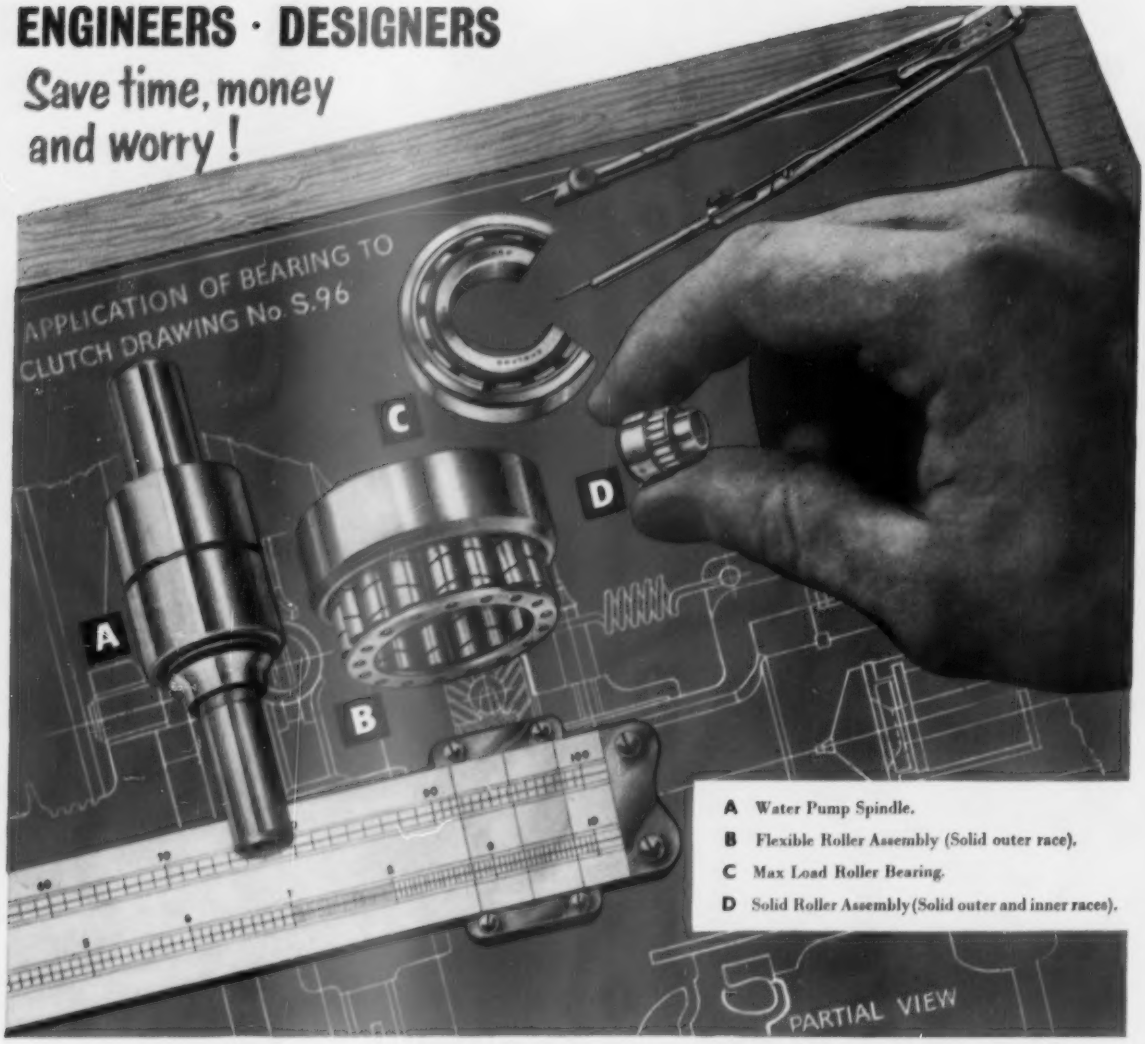
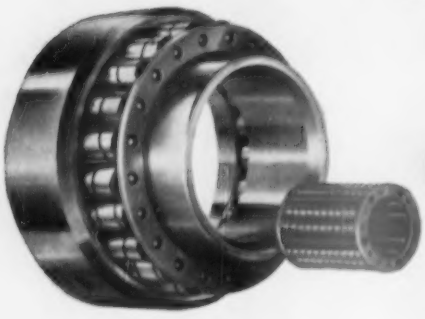


A Water Pump Spindle.
B Flexible Roller Assembly (Solid outer race).
C Max Load Roller Bearing.
D Solid Roller Assembly (Solid outer and inner races).



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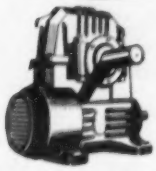

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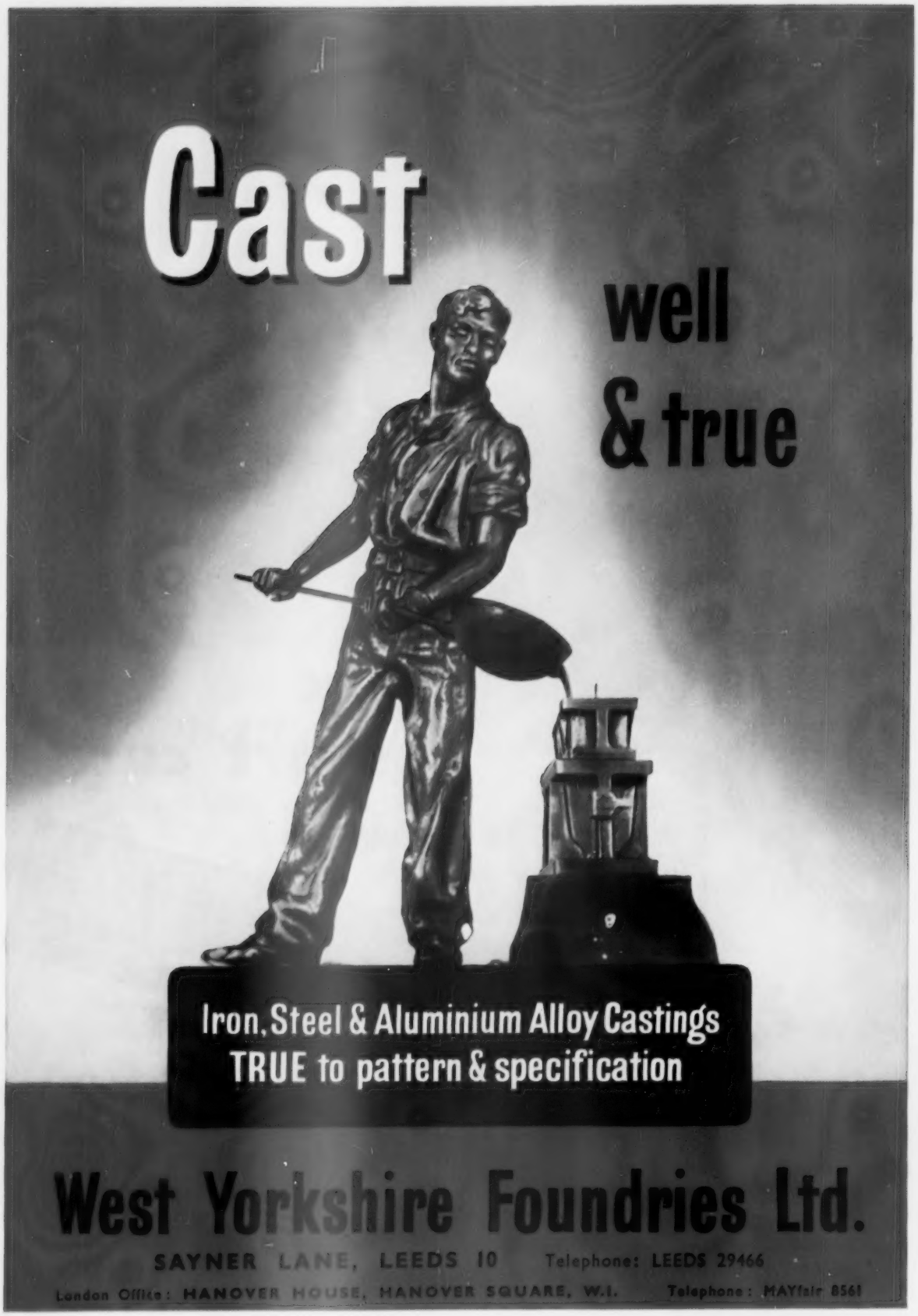
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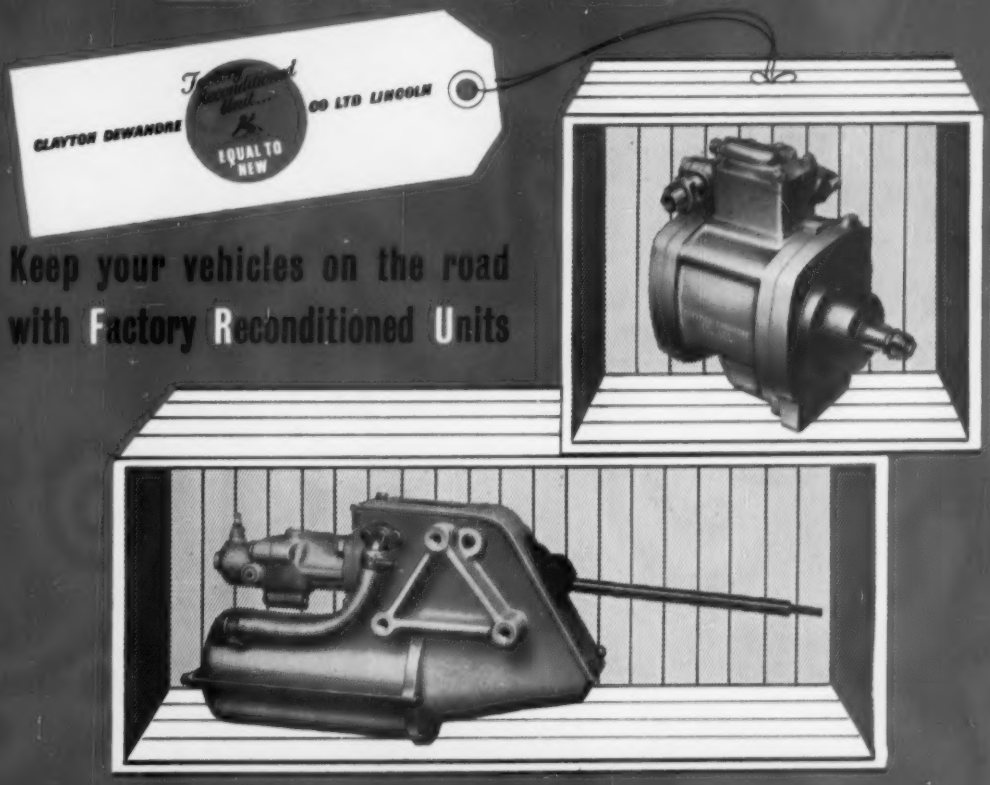

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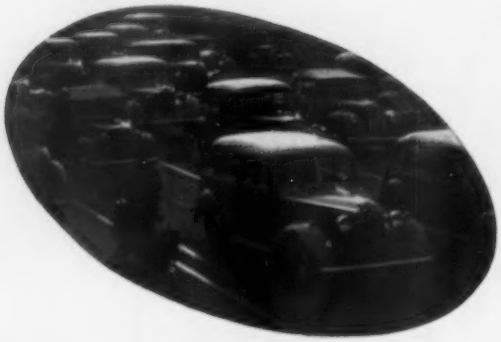

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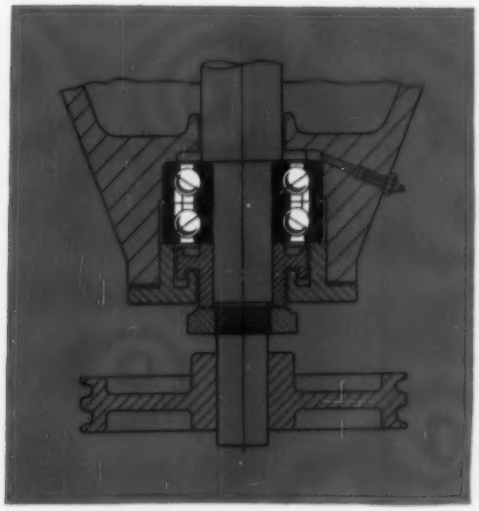

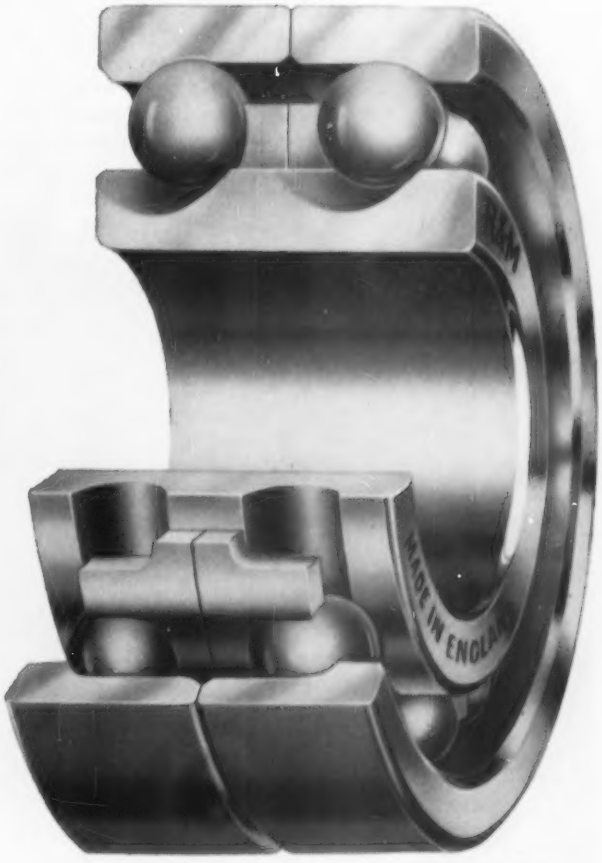

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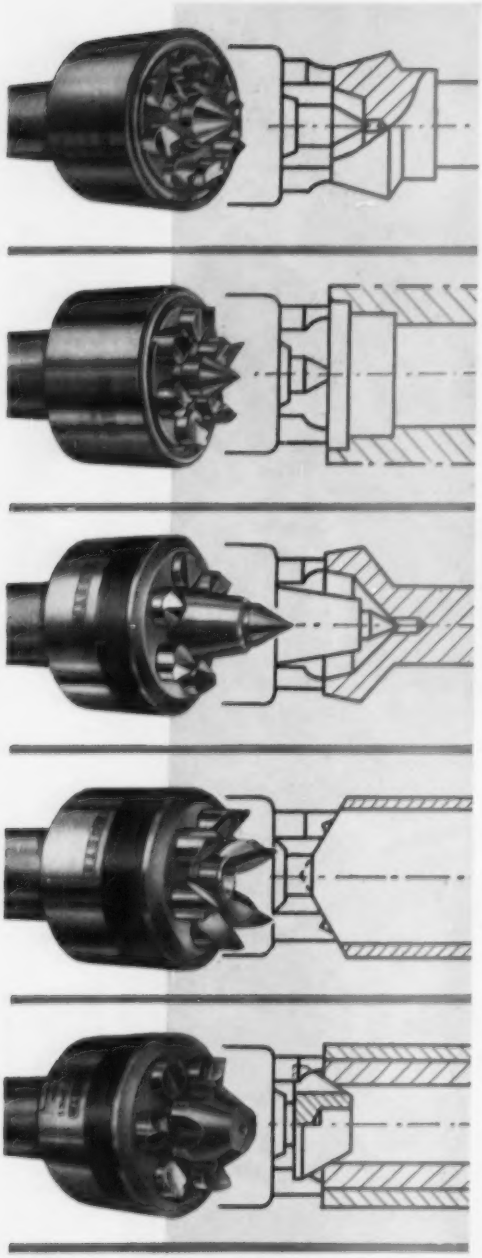

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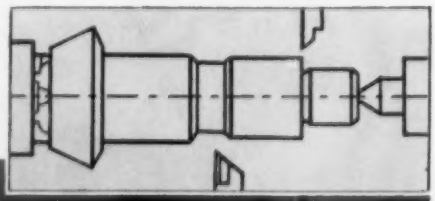

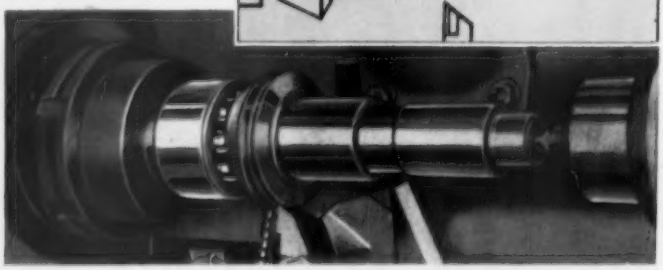

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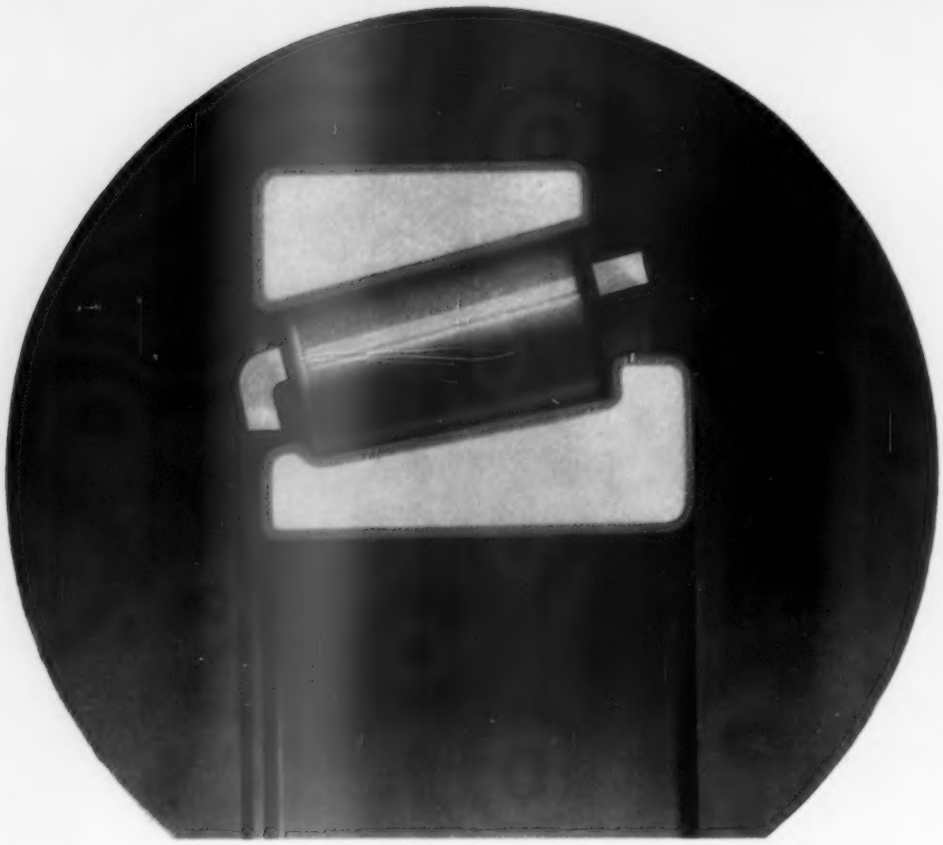

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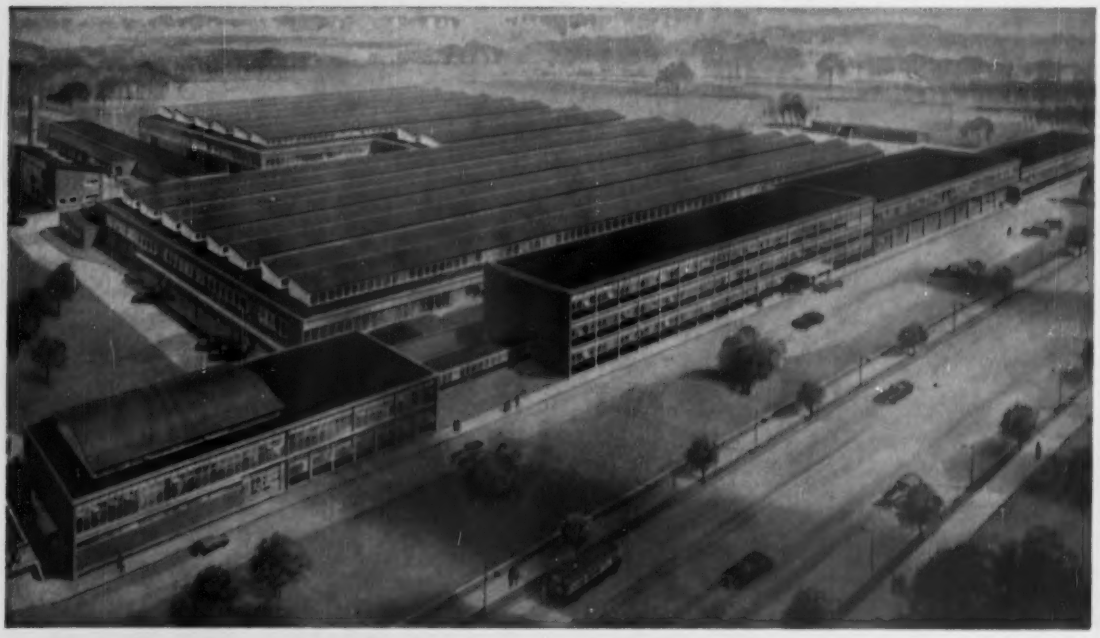

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VOLUME 46 NUMBER 12 NOVEMBER 28, 1956

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DESIGN MATERIALS **AUTOMOBILE ENGINEER** PRODUCTION METHODS WORKS EQUIPMENT

Another Year of Progress

DESPITE the fact that this year has been one of the most difficult for the motor industry since the War, British manufacturers are facing the situation with confidence because of new developments they have already introduced and others that are to follow. In the home market, credit restrictions, of course, have tended to make it necessary for manufacturers to reduce output; and rising costs both of production and of many raw materials have added to the difficulties. Abroad, as all know, increased competition and more stringent import controls have also reduced the demand. This has not exactly helped in reduction of cost.

Although many of these adverse developments were foreseen and allowed for by manufacturers, their full effects, nevertheless, have not yet had time to be reflected in the trends apparent in the Motor Show, nor are all the planned production improvements complete. This, of course, is because the rate at which design and production changes can be put into effect is restricted by the speed with which retooling can be accomplished economically.

So far as power units are concerned, the most significant development is the replacement of engines in some of the smaller cars by more powerful units. This trend undoubtedly will have a marked effect on chassis design in general, because the smaller cars will have to be laid out in such a way as to give better road holding and stability: they must be capable of being kept fully under control at high speeds, in case it should be necessary at a later date to equip them with still more powerful engines. Since this will tend to lead to the adoption of wider track dimensions, and perhaps to longer wheelbases, styling will also be affected. Any increase in track will be welcome, because it will also make possible improvements with regard to accessibility of the engine. If the performance of these vehicles is to be improved it seems likely that rear-engined cars will fall out of favour unless their handling characteristics can be improved.

The trend towards increased compression ratios will naturally improve fuel consumption. Criticism is sometimes levelled at British manufacturers to the effect that they do not produce cars that give such high figures, in terms of miles per gallon, as those obtained by some of the light-weight foreign vehicles. The answer to this is that British manufacturers do not produce such light cars because the demand hitherto has been overwhelmingly for larger vehicles. Expressed in terms of ton-miles/gallon the performances of, for example, the Jaguar 2·4 litre car, the Morris Isis and the Rover 90, as indicated by the results of the second Australian Mobilgas Economy Run, compare favourably with that of even the lightweight Goliath car, which won the event. The figures obtained were 57·4, 56·3, 56·6 and 63·0 ton-miles/gallon respectively. The Simca Elysée, which came second in the trial, had a fuel consumption of 58·9 ton-miles/gallon. Considering the fact that, so far as fuel consumption is concerned, light-weight vehicles are inevitably more economical to run than heavier ones, the performance of the British cars is outstandingly good.

Petrol injection has been developed to the stage where it can be placed in production for special applications, but it is hardly likely that it could yet compete, so far as cost is concerned, even with multi-carburettor layouts. An outstanding feature of the Show was the exhibition of two gas turbine cars. However, this type of power unit at present is only suitable for vehicles in which high performance and light-weight are over-riding considerations.

The Rover gas turbine car is most interesting because of its four-wheel-drive arrangement and the new suspension systems employed both at the front and rear. A noteworthy feature of the arrangement is the elimination of all except one sliding joint, which is incorporated in the de Dion tube at the rear and therefore does not transmit driving torque. Another interesting feature among the suspension systems is the application of the Macpherson arrangement, as used on the current Ford models, to the Allard Palm Beach. This system has many advantages, but hitherto has only been applied to chassisless vehicles.

The suggestions that have been made from time to time in *Automobile Engineer* to the effect that semi-automatic transmissions are likely to be introduced before the fully automatic types, as an optional extra on the smaller cars, appear to have been well founded. While a large number of the smaller saloon cars exhibited at the Show incorporated this feature, only big, more expensive vehicles have so far been equipped with fully automatic transmission. Of the fully automatic systems, those that do not incorporate hydraulic torque converters appear to be most suited for application to small cars of the type manufactured in large numbers in this country.

Rationalization by each manufacturing group is the outstanding trend with regard to body design. This has reduced costs, but the question arises as to what is the next step to take to meet competition abroad. Perhaps the answer to this is to pay more attention in the initial design stages to the arrangement of the panelling, in such a way that styling changes could be made more readily from time to time without extensive retooling.

EARLS COURT EXHIBITION

Engines

Further Increases in Power and Compression Ratio

MOST noticeable trend in engine design at the 1956 Motor Show was, of course, towards higher power output. In general, the increase has not been the result of radical changes in design, but rather of development by detailed modifications. Firstly, compression ratios have frequently been increased by up to one ratio. In most cases the increase does not necessitate a change in fuel from standard to premium or from premium to super premium, so the way to still higher compression ratios is still open. Several manufacturers offer their engines with the alternative of high or low compression, although normally only the high compression ratio is offered in the British home market. The alteration is made by fitting either alternative pistons or alternative cylinder heads.

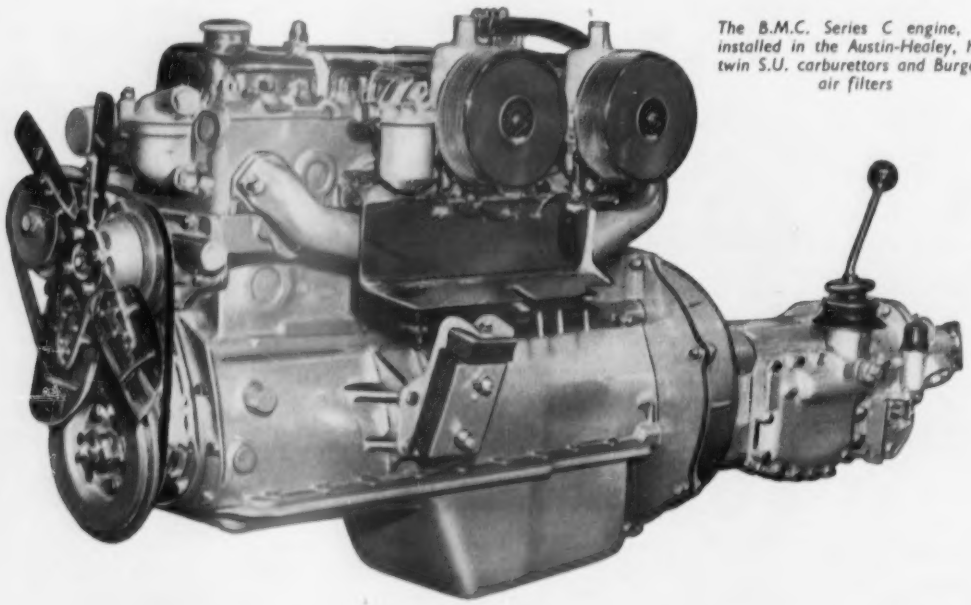
On several engines a considerable power increase has been obtained by fitting twin carburettors and by improvements in the induction system. Occasionally the diameter of the inlet and exhaust valves has been increased to improve volumetric efficiency. Larger cylinder bores account for some of the power increases, and in certain cases the maximum rated engine speed has been increased.

The increase in bearing loading due to higher compression ratios has led one large manufacturer to abandon white metal big end bearings in favour of the copper-lead type with overlay, and this tendency is discussed further on. It is interesting to note that the full-flow type of oil filter is being increasingly employed even on the lower-priced vehicles. Without good oil filtration the increase in engine life made possible by modern engine oils cannot be fully realized.

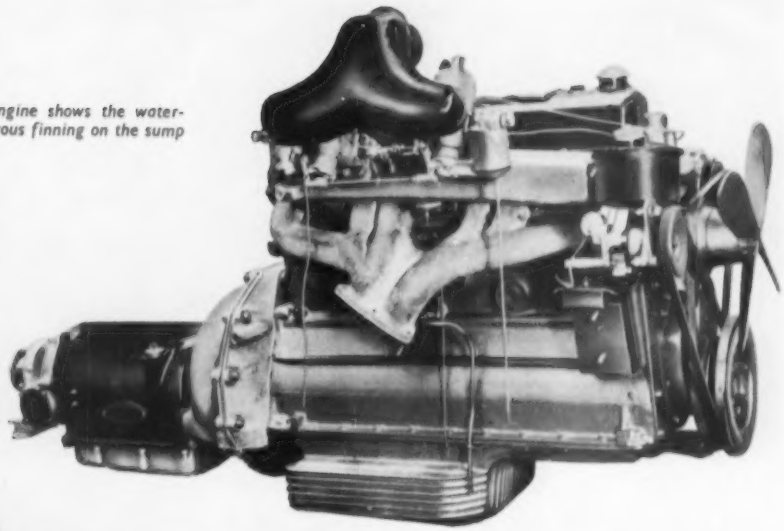
Water-cooled, four- or six-cylinder in-line engines with overhead valves operated by push rods remain the most popular European designs, whilst in America the water-cooled V-eight engine predominates. There are three new British engines which do not conform with the description just given. One is a light-weight, with twin overhead camshafts designed for racing purposes. Another is an air-cooled twin-cylinder, two-stroke, which has been adapted for use in a baby sports car. The third engine, a gas turbine, installed in a two-seater saloon, is not being produced commercially. It is clear, therefore, that these three engines will only be made in relatively small numbers, so that the general pattern of basic engine design has altered very little in the past year.

The diesel car engine has made no further headway and in view of the continued improvement of the petrol type there seems little likelihood of an early increase in the use of diesel engines in private cars. Although petrol injection equipment is being constantly developed, there is as yet no indication of its having reached the stage where it can challenge the carburettor on the grounds of cost and reliability.

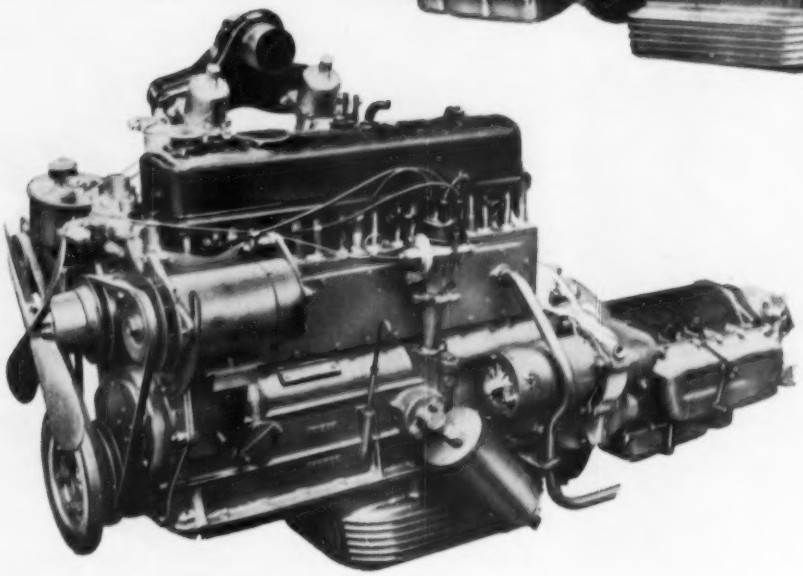
A considerable number of manufacturers is developing and investigating the possibilities of gas turbines and free piston gas generator turbine engines. The only engines in this class at the show were both gas turbines, one British and one French, but neither is being commercially produced. The British engine is fitted with a heat exchanger and appears to have far better prospects than the French engine. Whereas American faith appears to be pinned to the rotary type of heat exchanger, the British engine has the normal stationary type. The only other British automobile gas turbine with a heat exchanger also uses the stationary type.



The B.M.C. Series C engine, as installed in the Austin-Healey, has twin S.U. carburettors and Burgess air filters



This view of the Austin Princess IV engine shows the water-heated induction manifold and the generous finning on the sump



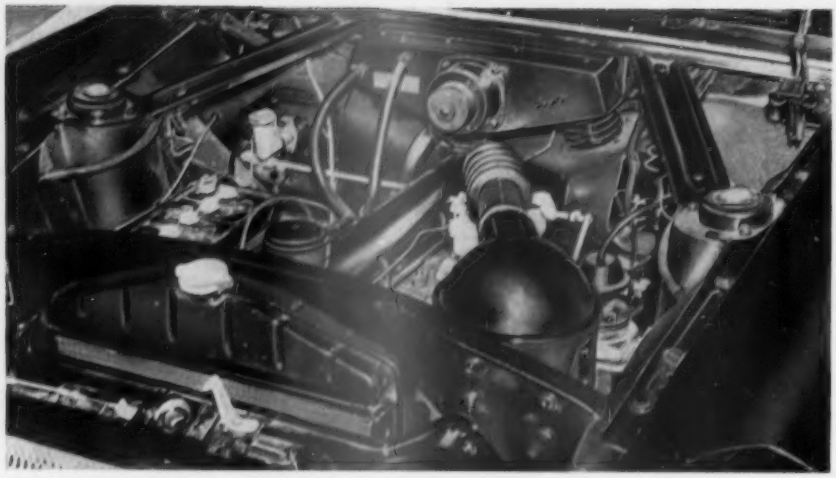
On the Austin Princess IV engine, the distributor is in line with the submerged oil pump

British Motor Corporation

Considerable changes have taken place in the British Motor Corporation's range of engines. The 800 cm³ engine which formerly powered the Austin A30 and the Morris Minor has been replaced by the new 950 cm³ A35 engine. The new engine is similar to the old one in appearance and has the same overall length, but the cylinder block has been redesigned to enable a larger bore to be used. The bore is increased from 58 mm to 62·9 mm but the stroke of 76 mm is unaltered. Cylinder bores have been siamesed and the top deck of the block is now thicker to permit a stronger fixing for the cylinder head studs. The water pump has been redesigned so that the bearings now run directly on the pump spindle without separate inner races and this has enabled a larger diameter pump spindle to be used. The same cylinder head and valve gear is used but the compression ratio has been increased from 7·2 : 1 to 8·3 : 1 by modifying the pistons. For certain overseas countries, the lower compression ratio pistons will continue to be available for customers who require them.

A copper and asbestos cylinder head gasket has been found more suitable at the higher compression ratio than the steel gasket formerly used. White metal big end bearings used on the A30 are now replaced by the lead-indium plated ones ; a full-flow oil filter is used instead of a by-pass filter. The crankshaft has been strengthened by increasing the crank-pin diameter from 1 $\frac{7}{16}$ to 1 $\frac{1}{2}$in. To ensure adequate sealing at the high gas pressures now encountered, the number of piston rings has been increased from three to four. Distributor timing has been altered to suit the higher compression ratio by modifying bob weights and springs. As previously, the Austin version has a Zenith carburettor whilst the Morris engine uses a S.U. unit. The A35 engine delivers 34 b.h.p. at 4,750 r.p.m. compared with 28 b.h.p. at 4,800 r.p.m. for the A30. Torque is increased from 40 lb-ft at 2,200 r.p.m. to 50 lb-ft at 2,000 r.p.m.

The B.M.C. Series B four-cylinder engine of 1,489 cm³ is used on the Austin A50, the Morris Oxford and Cowley, the Wolseley Fifteen-Fifty and the M.G. Magnette and M.G.A. Compression ratio has been increased to 8·3 : 1 by piston modification and various other changes have followed, as in the case of the A35. Lead-indium plated big end bearings are now used and a full-flow oil filter is fitted. A Zenith carburettor is used on the Austin version, whilst the Nuffield engines are fitted with S.U.'s. M.G. engines differ from the others in having twin carburettors and a modified camshaft.

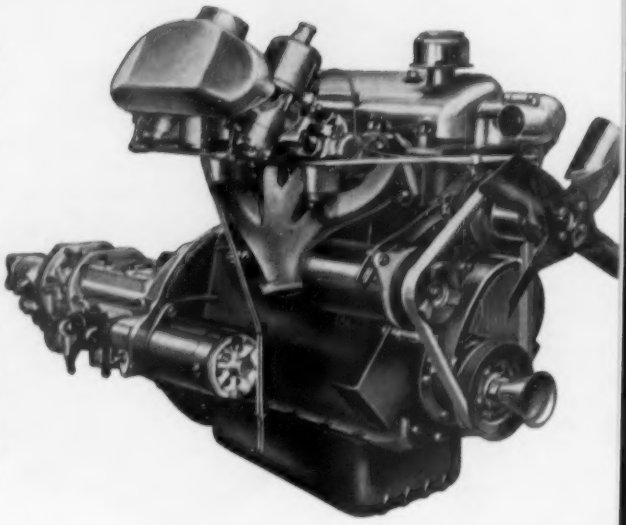


Installation of the Ford Zodiac engine. This vehicle is offered with overdrive, automatic transmission as an optional extra

A modified version of the Triumph TR3 engine is used in the new Standard Vanguard Sportsman

The B.M.C. Series C six-cylinder engine of 2,639 cm³ is used on the Austin A95 and A105, the Wolseley Six-Ninety, the Austin-Healey 100 and the Morris Isis. On the A105, the Wolseley Six-Ninety and the Austin-Healey, twin carburettors are used. Compression ratio is increased from 7·3 : 1 to 8·3 : 1 and lead-indium bearings and a full-flow oil filter are now employed.

The new Austin Princess IV saloon and limousine are powered by a redesigned six-cylinder, four-litre engine. The bore and stroke of 87·3 mm and 111·1 mm are the same as for the earlier A135 engine but the compression ratio is increased from 6·8 : 1 to 7·6 : 1 and a completely new cylinder head, based on the Austin-Healey 100S, is used. This design provides separate inlet and exhaust ports for each cylinder and facilitates the use of twin carburettors. The distributor is now vertically in line with the oil pump and is located on the left-hand side of the engine. Manifolds are on the opposite side and the inlet manifold is now water-heated. This new engine has a maximum power rating of 150 b.h.p. at 4,100 r.p.m. and a maximum torque of 227 lb-ft at 2,400 r.p.m.



Standard

A new Standard, the Vanguard Sportsman saloon, is powered by a four-cylinder engine of the same bore and stroke as the Phase III Vanguard, namely 85 mm and 92 mm respectively, giving a cylinder capacity of 2,088 cm³. In other respects, however, the engine is similar to the TR3 engine from which it has been adopted. Wet, centifugally cast cylinder liners of nickel-chrome iron are used on these three engines. The TR3 has a slightly smaller liner than the Sportsman, giving a bore of 83 mm, but the strokes of the two engines are the same. Both the latter engines have twin S.U. carburettors, whereas the Vanguard engine has a single, Solex downdraught unit. TR3 and Sportsman engines have the same design of cylinder head and have compression ratios of 8·5 : 1 and 8·0 : 1 compared with 7·5 : 1 for the Vanguard engine.

To accommodate higher gas loading on the cylinder heads of the TR3 and Sportsman engines, the cylinder head studs are extended to the lower deck of the block where a stronger fixing can be obtained. The Sportsman power unit develops a maximum of 90 b.h.p. at 4,500 r.p.m. compared with the 100 b.h.p. at 5,000 r.p.m. of the TR3 and 68 b.h.p. at 4,200 r.p.m. of the Vanguard. A full-flow oil filter is used on the Sportsman engine but the by-pass type is used on the TR3.

Ford

Introduced earlier this year, the engines of the new Ford Consul, Zephyr and Zodiac cars are similar in general design to those of the earlier models. As before, the four-cylinder Consul engine has the same bore and stroke as the six-cylinder Zephyr and Zodiac, but the dimensions have been increased from 79·4 by 76·2 mm to 82·55 by 79·5 mm. The cylinders thus remain slightly over-square, but the capacity of the four-cylinder engine is increased from 1,508 cm³ to 1,703 cm³ and that of the six-cylinder from 2,262 cm³ to 2,553 cm³.

Consul and Zephyr engines formerly had a compression ratio of 6·8 : 1, whilst the Zodiac was 7·5 : 1. Now all three engines have a standard compression ratio of 7·8 : 1 but an optional value of 6·9 : 1 is available for certain markets. The maximum rating of the Consul engine is increased from 47 to 61 b.h.p. at 4,400 r.p.m. while the rating of the six-cylinder unit is now 90 b.h.p. at 4,400 r.p.m. The former Zephyr and Zodiac engines were rated at 68 and 71 b.h.p. at 4,200 r.p.m.

A wedge-shaped combustion chamber is used, in which a considerable degree of turbulence is promoted by squish action between the flat piston crown and the cylinder head. As on the old engines, the push-rod operated, in-line, overhead valves are inclined at an angle of 14 deg to the vertical.

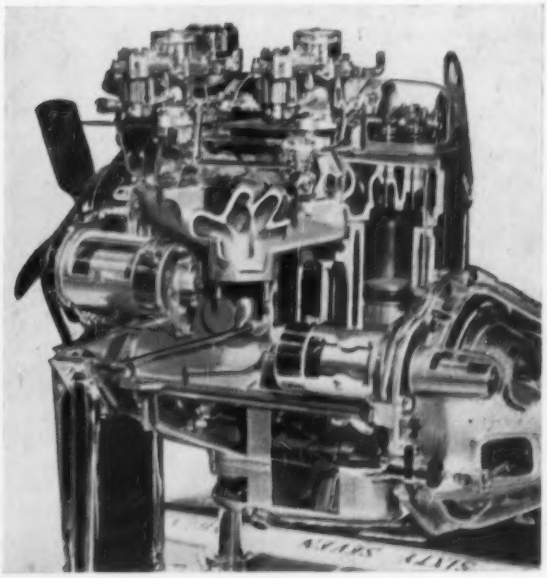
Valve guides are now dispensed with, and the exhaust valve operating temperature should therefore be considerably lower. Cost is also reduced and, should excessive wear between the valve stem and cylinder head make reconditioning necessary, valves of larger stem diameter will be available as replacements. Fully floating gudgeon pins, retained by circlips, are used instead of the clamped pin previously employed. The cast crankshaft has been redesigned for low weight and increased strength, a combination more readily achieved with a casting than a forging.

Rootes Group

Basically the same engines are used for the Sunbeam Rapier and the new Hillman Minx, the chief difference being between the induction systems. The capacity of these two four-cylinder overhead valve engines is 1,390 cm³ and the bore and stroke are each 76·2 mm. The two engines now have the same compression ratio, the Minx having been increased from 7 :1 to 8 : 1 since last year. Both have full-flow oil filters but white metal linings are still used for the main bearings and big ends. The Rapier engine now has twin carburettors and a single unit is fitted on the Minx. Maximum power of the Minx engine has increased from 47 b.h.p. at 4,400 r.p.m. to 51 b.h.p. at 4,600 r.p.m. (gross values). On the Rapier engine, the maximum rating is now 67 b.h.p. gross at 5,400 r.p.m. compared with the former rating of 62 b.h.p. at 5,000 r.p.m.

The engine of the new Singer Gazelle is a slightly modified version of that formerly used in the Hunter saloon and the SM1500 Roadster. This 1½ litre, four-cylinder overhead camshaft design has a bore of 73 mm and a stroke of 89·4 mm. Compression ratio has been increased from 7·2 : 1 to 7·5 : 1, and maximum power rating has correspondingly increased from 50 b.h.p. at 4,200 r.p.m. to 52·5 b.h.p. at 4,500 r.p.m. This rating seems quite moderate for an engine of this design and cylinder capacity and could probably be considerably increased with further development. A by-pass oil filter and an oil bath air cleaner and silencer, with a forward-facing air intake, are used. The valve cover is now built with a double skin to ensure quieter running.

This sectioned engine is the Rootes Group unit employed in the Sunbeam Rapier. Its bore and stroke are each 3in and it develops 67 b.h.p.



Berkeley

The new Berkeley, light-weight two-seater uses a modified British Anzani air-cooled engine with front-wheel drive. The engine has a bore and stroke of 60 mm and 57 mm respectively and a capacity of 322 cm³. It operates on the two-stroke cycle and has a rating of 15 b.h.p. at 5,000 r.p.m. The piston-operated valve ports are supplemented by a crankshaft-operated rotary air-inlet valve. An Amal carburettor with a horizontal choke is fitted, the petrol tank being mounted under the bonnet and supplying the carburettor by a gravity feed pipe.

Although no fan is used, measurements with thermocouples show that the engine can idle indefinitely without overheating. Twin forward-facing ducts direct air between the cooling fins of the cylinder block and head, assisted by a sheet aluminium cowling. The warm air is then directed upwards through an opening in the bonnet lid. In this way a chimney effect is achieved, which ensures satisfactory cooling even when the vehicle is stationary. The engine is mounted transversely ahead of the front wheel centres on three Silentbloc mountings.

The engine of the Berkeley two-seater vehicle, with the cooling air duct removed to show details of the installation

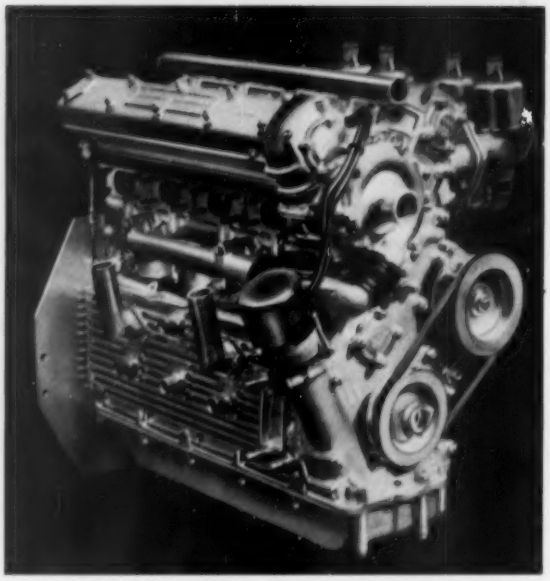
Clutch and gearbox are mounted behind the cylinders in a combined housing of aluminium alloy. Drive from the crankshaft to the clutch is through an enclosed roller chain on the left-hand side of the unit. The gearbox has three forward gears and reverse; drive to the differential is taken by an exposed roller chain which engages with a Tufnol sprocket on the differential unit. Starter and dynamo are combined in a single Siba dyna-starter, and light-weight construction of the whole car has resulted in a lively performance from an engine of only 322 cm³. It is hoped to obtain further improvements later on by installing higher powered engines up to 650 cm³.

Rolls-Royce

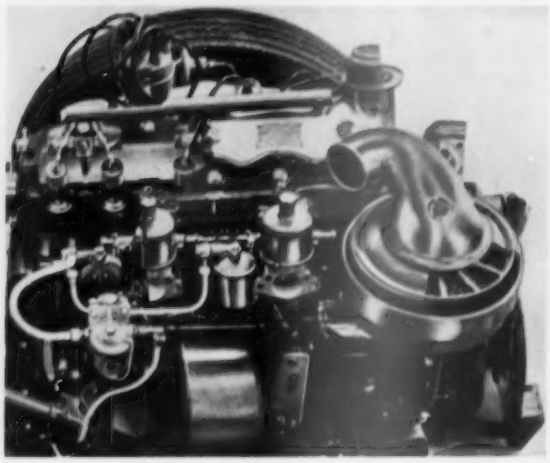
There are no significant engine changes to report from Rolls-Royce, but it is interesting to note than an engine-operated refrigerator unit of the type already used in

America can now be supplied on the Silver Wraith. The refrigerator unit has three major components:—a compressor, a condenser and an evaporator. The compressor is a standard two-cylinder Tecumseh unit and is mounted on the top right-hand side of the engine. It is driven by twin belts from the water pump pulley and incorporates a solenoid-operated clutch, which is engaged when the unit is brought into operation. The condenser consists of a finned-tube coil of three passes, mounted in front of the radiator. The evaporator unit is situated in the boot behind the rear seats. Two electrically-driven centrifugal blowers force a supply of air through the evaporator to the body. Below the compressor unit is a pressure-controlled by-pass valve, which regulates the amount of refrigerant circulated and maintains the evaporator at a constant temperature when the car is moving at more than 20 m.p.h. The unit is controlled by a single knob, which engages the compressor clutch and varies the speed of the blowers in the cooling unit.

The engine of the Bentley Continental has received a number of minor modifications. The cylinder head has been redesigned to increase the compression ratio from 7·25 : 1 to 8 : 1. Larger diameter inlet valves have been introduced and the cooling of the exhaust valves has been improved. The throat diameter of the twin S.U. carburettors is increased from 1¾in to 2in. Rolls-Royce and Bentley do not publish details of engine performance but it is stated that the horsepower of the modified engine is 13 per cent greater than before.



Coventry Climax Formula II engine, with twin overhead camshaft. This unit develops more than 140 b.h.p.

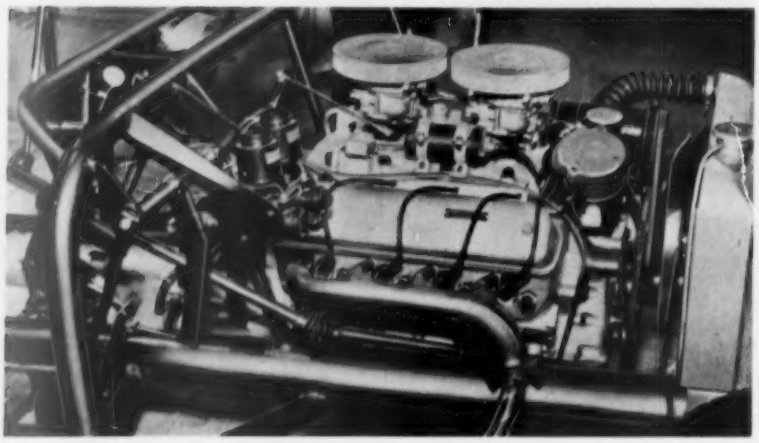


Twin S.U. carburettors are employed on the Rover 105 engine and their air supply is drawn through a common filter

Rover, Vauxhall and Frazer-Nash

Two new Rover saloon cars, the 105R and 105S, are powered by a Rover 2·6 litre engine. The 105R model has a new Rover-designed automatic transmission whilst the 105S has a standard gearbox with automatic overdrive. The engine used is very similar to that in the Rover 90, but the power has been increased from 93 b.h.p. at 4,500 r.p.m. to 108 b.h.p. at 4,250 r.p.m. Part of this increase is obtained by raising the compression ratio from 7·5 : 1 to 8·5 : 1 while further increase is attributable to induction modifications, including the use of twin horizontal carburettors. The usual Rover combustion chamber is used, with side exhaust valves operated directly by the camshaft and overhead inlet valves operated through push rods.

A few minor changes have been made to the four-cylinder Wyvern and the six-cylinder Velox and Cresta engines. These formerly had a compression ratio of 6·5 : 1 for use with standard petrol or 7·3 : 1 for use with premium petrol. These values are now increased to 6·8 : 1 and 7·7 : 1. Cylinder heads are stamped either H or L on the off-side to indicate the compression ratio supplied. A new design of Zenith carburettor is now fitted which is stated to give better



The Frazer-Nash Continental chassis is powered by the B.M.W. V-eight engine

starting with a hot engine, due to reduced percolation, and better starting on a gradient because of an increased spill angle.

The engine for the new 2½ litre Frazer-Nash Continental has been derived from the B.M.W. 2·6 litre V8. Capacity has been reduced from 2,580 cm³ to 2,430 cm³ by using sleeves of 72 mm bore instead of 74 mm. Wet sleeves are used in an aluminium alloy block. Two, twin-choke down-draught carburettors are fitted, as on the 3·2 litre engine. The B.M.W. designs retain the distinction of being the only European V8 engines at the Show.

Coventry Climax

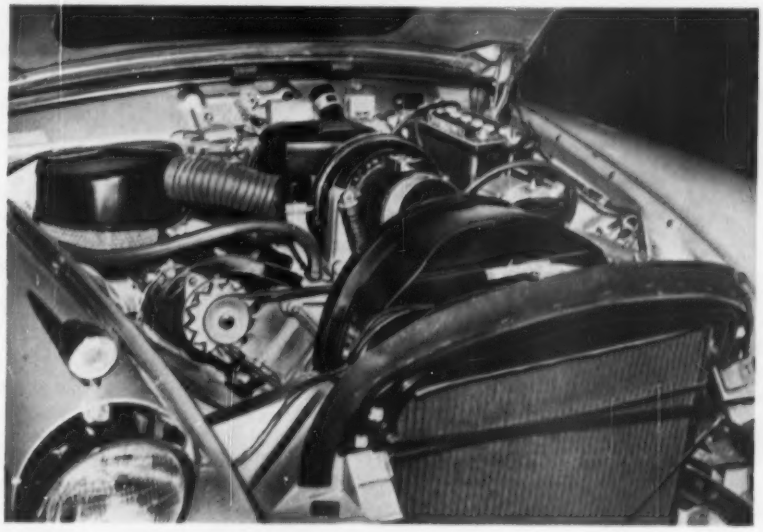
The Coventry Climax, four-cylinder FPF engine is intended for Formula II racing cars and is used in the new Lotus car. Like the Coventry Climax 2½ litre V8 engine, this new 1½ litre unit has twin overhead camshafts, whereas existing Coventry Climax four-cylinder engines have a single overhead camshaft. The FPF develops a maximum power of 141 b.h.p. at 7,000 r.p.m. Maximum speed is at present limited to 7,500 r.p.m. A compression ratio of 10 : 1 and 100 octane fuel enable a maximum b.m.e.p. of 181·5 lb/in² at 6,500 r.p.m. to be achieved. The cylinders are rather over-square, having a bore of 81·2 mm and a stroke of 71·1 mm, with a cylinder capacity of 1,475 cm³. Every effort is made to achieve light weight, the cylinder head being of light alloy, with inlet and exhaust valves inclined at an included angle of 66 deg. The block itself is also cast in light alloy and is fitted with wet liners. The top of each liner is sealed by a metallic cylinder head gasket and the bottom seal is a circular section rubber ring. Wherever possible, magnesium alloy is used for further weight saving. This applies to non-stressed parts, such as the tappet and timing drive covers and the sump. The weight of the bare engine is 255 lb, or 280 lb with starter and dynamo.

All five main bearings and the big end bearings are fitted with indium-plated, lead-bronze lined steel shells. The fully balanced crankshaft has 2¼in diameter main journals, while the crank pins are 2¼in diameter. Dry sump lubrication is employed, with a scavenge pump situated at both ends of the sump. The pressure pump is located between them ; the three pumps, mounted below the main bearing caps, are driven from the camshaft gear train at the front of the engine. Case-hardened and ground spur gears are used, one driving the water pump, which is situated in the timing drive cover.

American engines

Despite the high power already delivered by many American engines, development continues to be aimed at producing still greater power. In general, the approach taken has been to improve engine breathing capacity and to raise compression ratios still further. Ratios up to 10 : 1 are offered, and it may well be that with further improvements in combustion design even higher values will be employed. Some manufacturers continue to offer their engines with a comparatively low alternative compression ratio of 7 : 1 or so for use with the lower grades of petrol. The V-eight engine continues to dominate the American market, but a few six-cylinder in-line engines of established design are still employed. The reasons for the dominance of the V-eight engine were discussed in an article in the May 1956 issue of *Automobile Engineer*.

One manufacturer has sought additional power by resort to a supercharger. The Studebaker Golden Hawk has a belt-driven, centrifugal supercharger mounted on top of its V-eight engine, with the blower shaft parallel to the crank-shaft. The supercharger pulley is of variable-speed design. Pressurized air is fed to a totally-enclosed Stromberg carburettor located behind the blower. Performance figures are not yet available, but the design suggests that the amount of boost is fairly low.



In this view of the Studebaker Golden Hawk engine installation, the belt-driven supercharger and large cowling over the fan can be seen clearly

The arrival of high octane fuel in the petrol pumps of America and other countries calls for a reassessment of the relative advantages of supercharging and raising the compression ratio. By raising the compression ratio of an engine to the limit set by detonation, the specific fuel consumption is reduced and power output is increased. When an engine is operating near the limit set by detonation, supercharging is likely to result in excessive engine wear and overheating without any gain in performance. If, however, the compression ratio is kept to a fairly low value and the engine run on high octane fuel, it can be supercharged to a considerable boost pressure without danger of detonation. In this way the power output is increased to a much greater extent than by raising the compression ratio to the extreme limit. On the other hand, the lower compression ratio results in a higher specific fuel consumption.

It seems that the American market is calling for ever greater engine power, and it is possible that certain customers would be prepared to sacrifice fuel economy for really significant power increases. In fact, there may well be a

market in which the supercharged petrol engine will be competing with the gas turbine by offering a very high power : weight ratio combined with a specific fuel consumption, which is rather high when compared with that of a normally-aspirated, high compression ratio engine.

Continental engines

The Renault Dauphine saloon introduced earlier this year has an 845 cm³ engine developed from the well known Renault 750 unit. In appearance, the new engine is practically identical to its predecessor and most of the component parts are interchangeable. Both engines have a stroke of 80 mm and a compression ratio of 7·25 : 1, but the bore of the Dauphine engine is 58 mm compared with 54·5 mm for the 750 unit. The same cylinder casting is used for the two engines but the Dauphine engine is bored out to take a larger liner. Wet liners are used, and the locating bore on the 750 engine has now been increased so that the large and small liners are interchangeable. Thus, the capacity of a 750 engine of recent manufacture can be increased by fitting the larger liners and pistons. The carburettor, cylinder head and valve sizes are unchanged and it might, therefore, have been expected that the b.m.e.p. of the Dauphine engine would be somewhat lower than that of the 750 unit.

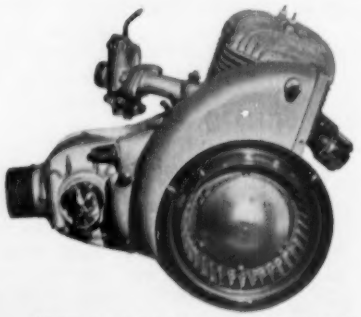
It is therefore somewhat surprising to note that the power of the Dauphine engine is quoted as 30 b.h.p. at 4,250 r.p.m. compared with 21 b.h.p. at 4,200 r.p.m. for the 750; that is, a power increase of 43 per cent for an increase in cylinder capacity of 13 per cent. The new engine uses the same thermostatically-controlled hot spot and automatic choke as is fitted to the 750 unit. The engine is mounted with the flywheel and drive nearest the front of the vehicle and the whole mounting is extremely flexible. A pair of steel stays is bolted to the sides of the rear of the engine, and the outer ends of the stays are carried on rubber mountings acting in shear. The radiator is mounted between the engine and the rear seats; it is pressurized and arranged for horizontal flow of the coolant. A radiator blind is provided, enabling the driver to regulate engine temperature by reference to the thermometer on the dash.

The Goggomobil T.300 baby saloon, shown for the first time in this country, is manufactured by Hans Glas G.m.b.H. It has a twin-cylinder, air-cooled, two-stroke engine mounted transversely at the rear of the vehicle. Its two cylinders have cooling fins of generous dimensions, which are integral with the barrel. Each cylinder is a separate iron casting secured to the crankcase by four long bolts. These same four bolts hold down the cylinder heads, which are detachable light alloy castings. The crankcase is also made in light alloy and is split horizontally. The gearbox is integral with the crankcase and located at one end of the crankshaft, from which the drive is taken by helical gearing. Four forward speeds and reverse gear are obtainable. The differential housing is incorporated in the crankcase castings. Drive from the gearbox to the differential is also taken by helical gearing and the whole unit is extremely compact.

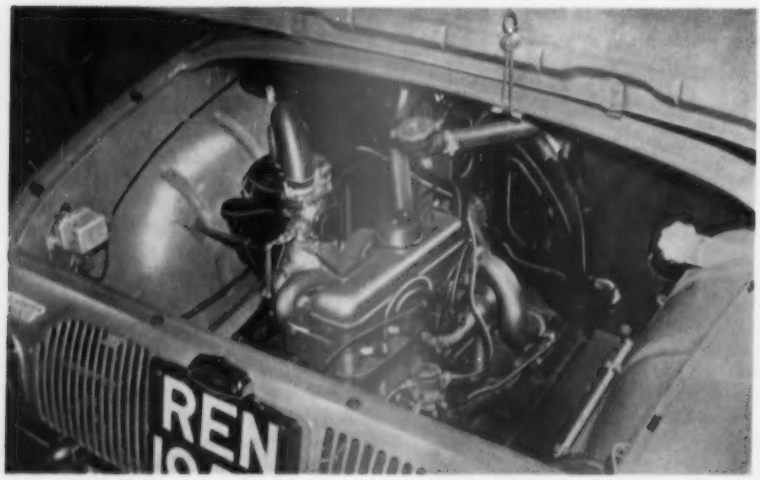
A Bing horizontal carburettor draws air from an oil bath filter and silencer unit bolted to the floor of the engine compartment. The flywheel is situated at the opposite end of the crankshaft to the driving end and incorporates a radial-entry centrifugal cooling fan. The flywheel and fan housing is a separate light alloy casting, which contains a diffusing delivery branch. Air enters the engine compartment through two sets of five slits cut in the rear wings. Sheet metal ducting leads the cooling air from the fan and directs it over the block and head, after which the air is discharged through the floor of the engine compartment. The crankshaft runs in three roller bearings. A bore of 58 mm and a stroke of 56 mm give a capacity of 293 cm³, and the rated power output is 17 b.h.p. at 6,000 r.p.m.

The new Lancia Flaminia has a V-six engine similar to that used in the Aurelia model. The bore has been increased from 78 to 80 mm, whilst the stroke has been reduced from 85·5 to 81·5 mm, giving the Flaminia a swept volume of 2,458 cm³ compared with 2,451 cm³ for the Aurelia. Compression ratio is 8 : 1 and the gross maximum power rating is 98 b.h.p. at 4,800 r.p.m. A Solex twin-choke carburettor is used, with a water-heated induction manifold as on the Aurelia engine, but the heat transfer area has been considerably increased. As before, a single, chain-driven camshaft is located between the two banks of cylinders, which form a 60 deg V.

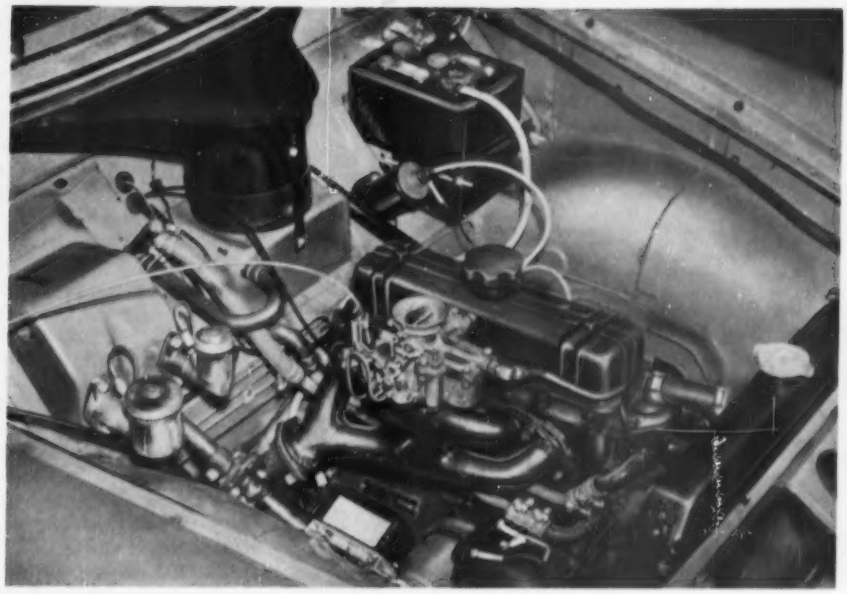
Modifications to the Appia four-cylinder engine include the fitting of a larger carburettor, which incorporates an acceleration pump. A further modification which goes against the general trend at this year's show is a reduction



Compactness is a noteworthy feature of the engine and transmission unit employed in the Goggomobil, of Bavarian manufacture



Accessibility to the engine is a good feature of the Renault Dauphine installation, which does not differ greatly from that of the Renault 750



A single casting forms the inlet and exhaust manifold unit on the Volvo Amazon engine

in compression ratio from 7·4 : 1 to 7·2 : 1. The hemispherical combustion chamber has been modified and the net effect of these changes is an appreciable increase in both maximum power and maximum torque.

The new Volvo Amazon saloon has a four-cylinder 1·6 litre engine of conventional design, with water-cooling and push rod operated valves. A single casting incorporates the induction and exhaust manifolds, so that the inlet air is considerably pre-heated. As on the 1·4 litre Volvo engine, a stroke of 80 mm is used, but the bore is increased from 75 to 79·4 mm. The compression ratio is 7·5 : 1 compared with 7·8 : 1 on the earlier engine, and a single Zenith carburettor is used in place of the twin S.U. units. The engine is rated at 60 b.h.p. at 4,500 r.p.m., while the maximum torque is 82·7 lb-ft at 2,500 r.p.m. Chromium plated compression rings are fitted in order to reduce wear and an AC full-flow oil filter is used. This is bolted directly to a machined face on the right-hand side of the crankcase. A helical gear drive is used for the camshaft, the camshaft gear being made of plastics for greater silence. Tappets rotate under the action of the camshaft, ensuring more uniform wear of the working faces. All the engine accessories have been located in easily accessible positions. A six-volt electrical system is used with the starter and dynamo mounted on the right-hand side. The distributor and AC fuel pump are mounted on the opposite side of the engine.

Gas turbines

A further stage in the evolution of a gas turbine suitable for motor cars is marked by the development of the new Rover T.3 engine. This is used to power an attractive saloon of sporting appearance, which has been specially designed to suit the new gas turbine unit. The engine is mounted at the rear, and four-wheel drive is employed in order to take full advantage of the high starting torque available.

The T.3 is the third gas turbine prototype to be developed by Rover. The first, designed for a maximum power of 200 b.h.p., was successfully demonstrated in 1950 in the world's first turbine car. Later the same engine was installed in a motor launch. The need for a heat exchanger has always been fully appreciated by Rover, and the design was such as to permit the fitting of one at a later stage of development, although it does not appear that this was, in fact, carried out. The second Rover gas turbine was designed for 120 b.h.p. maximum power and was rear-mounted in a normal Rover saloon car. Like the first, this engine was not equipped with a heat exchanger.

The T.3 is a development of the Rover 1S/60 industrial gas turbine which was exhibited at the British Industries Fair in Birmingham in 1954. The 1S/60 is a simple design without a heat exchanger and is suitable for those applications where low weight is more important than low fuel consumption. A single-stage, centrifugal compressor drives a single-stage axial turbine at a maximum speed of 46,000 r.p.m. The continuous rating at this speed is 60 b.h.p. and the corresponding fuel consumption is 1·4 lb/b.h.p.-hour. The engine is able to run on a variety of liquid and gaseous fuels including petrol, diesel oil and kerosene. With a bare engine weight of only 116 lb, the 1S/60 is extremely portable, and one of its first applications was a portable fire pump unit that could easily be carried by two men.

Before the 1S/60 could be applied to a car, several modifications were necessary. In order to avoid the need for a gearbox or torque converter, a free power turbine had to be provided. This takes the form of a single-stage, axial turbine located immediately downstream of the compressor turbine, with an intermediate set of nozzle blades. The second modification was an increase in engine rating, in order to secure higher power output and lower specific fuel consumption. At 46,000 r.p.m. maximum speed, the 1S/60 had a compressor pressure ratio of 2·9 : 1, a turbine inlet temperature of 790 deg C and an air flow of 1·35 lb/sec. The power, as stated earlier, was 60 b.h.p. The maximum compressor speed of the T.3 has been increased to 52,000 r.p.m. at which speed the pressure ratio is 3·85 : 1. Corresponding air flow is 2 lb/sec and the turbine inlet temperature is 830 deg C. This increase in compressor speed, amounting to 13 per cent, results in a maximum of 110 b.h.p., an increase of 83 per cent.

These figures are striking evidence of the rapid variation of gas turbine performance with rotor speed and are in contrast to the behaviour of a piston engine. The higher pressure ratio and temperature can also be assumed to have resulted in an improvement in specific fuel consumption. This behaviour is also in contrast to that of the piston engine, the compression ratio of which is not affected by engine speed and whose specific fuel consumption is not therefore so closely linked to engine speed.

The air supply for the Rover T.3 gas turbine is taken in through an aperture in each rear wing. Below the right-hand side of the heat exchanger can be seen the combustion chamber

The third modification to the 1S/60 has been the addition of a heat exchanger. A heat exchanger is essential if the fuel consumption of a small gas turbine is to be reduced to a value comparable with that of a petrol engine. Other methods of reducing fuel consumption, such as raising the pressure ratio and improving the compressor and turbine efficiencies, are helpful, but cannot solve the problem by themselves. The rate of improvement of component efficiencies inevitably diminishes as these efficiencies approach the maximum possible values. The pressure ratio obtainable in a single-stage compressor is limited by the increased stress that accompanies any increase in speed and the limiting strength of available materials. The benefit that can be obtained from an efficient heat exchanger is very much greater than could be obtained in any other way, and a heat exchanger has therefore to be accepted in spite of the complication it brings to an otherwise simple and compact engine.

The T.3 heat exchanger is of the plate type with secondary surfaces. Exhaust gases and compressed air flow between parallel plates in approximately counter-flow. The secondary surfaces serve to increase the heat transfer between the gases and the plates, according to the same principle that is used on conventional motor car radiators. Details of the heat exchanger have not been released, but it can be assumed that the plates have been made of very light gauge in order to achieve low weight. The heat exchanger is mounted directly on top of the engine and is quite compact.

From its small size, it seems unlikely that the thermal ratio can be more than 60 or 70 per cent. If a figure of 65 per cent is assumed, an estimate can be made of the improvement in fuel consumption resulting from the addition of a heat exchanger. The temperature of the air leaving the compressor must be about 190 deg C for a pressure ratio of 3·85 : 1. Temperature drop in a compressor turbine is rather less than the temperature rise in the compressor and may be estimated at 160 deg C. The temperature drop in the power turbine, estimated from the power output and the air flow must be about 85 deg C.

As turbine inlet temperature is stated to be 830 deg C, the temperature of the exhaust gases entering the heat exchanger should be about 830 − (160 + 85) or 585 deg C. The maximum temperature difference between the exhaust gases and the compressed air is 585 − 190, or 395 deg C. Temperature rise of the air in the heat exchanger can therefore be estimated at 395 × 0·65, or 257 deg C. The temperature rise between the compressor and the turbine inlet is 830 − 190, or 640 deg C; the temperature rise in the combustion chamber is therefore 640 − 257, or 383 deg C. Therefore, as a rough estimate, the fuel consumption of the T.3 would be about 67 per cent greater (that is, $\frac{257}{383} \times 100$) without a heat exchanger.

This estimate is based on a heat exchanger efficiency of 65 per cent. Corresponding estimate of the specific fuel consumption, based on a value of 1·4 lb/b.h.p.-hour for the 1S/60, is ·85 lb/b.h.p.-hour. No allowance has been made for the loss of power due to pressure losses on the compressed air and exhaust gas sides of the heat exchanger. On the other hand, the improvement in specific fuel consumption due to the higher operating speed of the T.3 has also been ignored and this effect should more than offset the effect of pressure losses on the specific fuel consumption. This rough calculation serves to show the great reduction in fuel consumption when a heat exchanger is fitted. Nevertheless, it is clear that still further development is required before the gas turbine can compete with the petrol engine in fuel economy.

Apart from improving fuel consumption, the heat exchanger serves a useful purpose in reducing the temperature of the exhaust gases. Without a heat exchanger, the gases would be discharged to the atmosphere at 585 deg C, with the engine operating at full power. Although the gases are directed upwards at the rear, a large flow of air at this high temperature could prove a nuisance. The heat exchanger reduces it to approximately 350 deg C, a less objectionable value. Furthermore, the density of the exhaust gases is reduced, so that a smaller exhaust duct suffices. When the engine is idling, the temperature and rate of flow of the exhaust gases is, of course, very much reduced. Finally, the heat exchanger serves another useful purpose by reducing the level of exhaust noise from the engine.

Air enters the engine through a pair of ducts drawing air from two openings on top of the rear wings. Exhaust gases escape directly from the heat exchanger through a square opening in the boot lid. The engine is mounted with the rotor axis running fore and aft and the compressor facing the rear of the car. As stated earlier, the basic engine design is similar to that of the 1S/60, and a few further features of the latter engine are therefore worth recapitulating. The compressor impeller is machined from an aluminium alloy forging and is of single-sided design with 17 vanes. Rotating guide vanes of steel guide the air into the eye of the impeller. On leaving the impeller, the air enters a diffuser, which has nine vanes. A centriflow combustion chamber of Lucas design is used on the 1S/60 engine but a new straight-through combustion chamber has been employed on the T.3. The turbine is machined from a Nimonic 90 forging and has 31 integral turbine blades of free vortex design. There are 21 turbine nozzle blades. Since the T.3 has a separate power turbine, the turbine on the compressor shaft is only required to drive the compressor and auxiliaries, and some redesign has probably been necessary in order to reduce its output.

Two bearings carry the compressor shaft of case-hardened steel: one is a ball bearing on the air inlet side of the impeller, and the other is a roller bearing on the compressor side of the turbine rotor. The inner race of the roller bearing is machined in the main shaft. This shaft extends beyond the compressor bearing and carries a helical gear, which drives the gear train for the auxiliaries and the main drive.

In the case of the T.3, of course, the main drive is from the free power turbine through a 7·45 : 1 reduction gear. This gear incorporates a reverse gear, which is selected by a control lever. The generator is driven by the power shaft. A 12-volt starter motor is used, which drives the compressor through a 10 : 1 step-up ratio and is automatically cut out at the self-sustaining speed of the compressor shaft by a Servo

switch operated by the compressor delivery pressure. The idling speed of the compressor shaft is 15,000 r.p.m. Should the combustion chamber fail to light up on starting, the surplus fuel is drained from the combustion chamber and engine casing by means of an automatic air-operated valve in the bottom of the engine casing. In this way the danger of excessive temperature being produced in the turbine, when the combustion chamber eventually lights up, is avoided.

The Rover Company are to be congratulated on having produced what appears to be a practical gas turbine engine for a motor car. The company themselves emphasise that there is no question of production at the moment, presumably because the project is not yet regarded as economic. However, it is clear that great progress has been made in the past few years and, if this rate of progress is maintained, a gas turbine car may well be finding a limited market for itself in a few years time.

The Renault experimental racing car, l'Etoile Filante, is powered by a Turbomeca gas turbine. The Turbomeca company produce a variety of gas turbine engines, all of which are developed from a single basic design. Each engine has a centrifugal compressor with a 16-vane impeller of aluminium alloy. The rotating guide vanes at the eye of the impeller have a particularly wide chord. After leaving the compressor diffuser, the air turns through a right-angle and enters a second diffuser, in which the flow is axial. This diffuser discharges into an annular combustion chamber surrounding the main shaft. Fuel is supplied through the shaft and is centrifuged into the combustion chamber through a number of radial holes. A two-stage, axial-flow turbine is mounted on the compressor shaft downstream of the combustion chamber, and, as on the Rover engine, the turbine blades are integral with the turbine disc.

The engine used in the Renault car is a Turmo I which is fitted with a free power turbine in order to give the required torque : speed characteristic. Maximum power delivered is 270 b.h.p. at a power turbine speed of 28,000 r.p.m. and a compressor speed of 35,000 r.p.m. Corresponding air flow is 4·75 lb/sec at a pressure ratio of 3·8 : 1. The specific fuel consumption at maximum power output is 1·0 lb/b.h.p.-hour. This value cannot be considered particularly high for an engine of such simplicity of construction. Without the reduction gear, the weight of the engine is only 300 lb. One of the outstanding features of the Turbomeca engine is the compactness of its combustion chamber, which is neatly housed between the compressor and turbine without any external ducting. Although this design of combustion chamber contributes to the success of the engines as portable power units and air compressors, it becomes a handicap when the engine is regarded as a prototype for road vehicles. The compactness of the combustion chamber and the complete absence of ducting appear to make it practically impossible to fit a heat exchanger to the Turmo I engine. For this reason it seems unlikely that this engine can be applied to road vehicles in any commercially significant numbers.

Bearing materials

As compression ratios have risen in recent years so bearing pressures on engine big end and main bearings have increased. Bearing designers regard the maximum average loading suitable for white metal bearings as about 2,500 lb/in^2. The big end bearings of many engines have now reached this limit and, if compression ratios are still further increased, the rate of wear of white metal bearings is likely to become excessive. Consequently, in order to take advantage of the higher compression ratios made possible by high octane petrol, it becomes desirable to fit bearings capable of withstanding higher loads. A steel shell bearing, lined with 30 : 70 copper-lead, will take loads up to 4,500 lb/in^2 with a satisfactory rate of wear, but the frictional loss is higher than that for white metal. By applying a thin layer of special material to the surface of the bearing, its frictional properties can be improved without seriously reducing its load-carrying capacity. Two such types of bearing are in use. The advantage they offer seem to more than offset the increased cost, and these bearings are therefore likely to be increasingly employed for engine big ends.

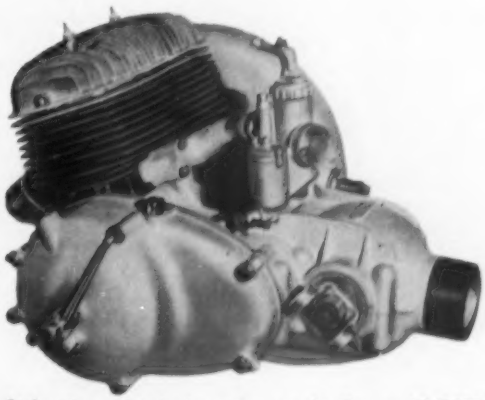
The Glacier Metal Company supply steel-backed copper-lead bearings in which a lead-tin overlay forms the running surface. The proportion of lead to tin is 90 : 10 and the two metals form a eutectic, which is electrolytically deposited on the copper-lead. The thickness of the lead-tin layer may vary from 0·00025–0·002 in. Too small a layer will mean a short life for the bearing, due to the surface wearing through too rapidly, while too thick a layer is liable to lead to cracking of the surface. Vandervell Products produce a similar type of bearing, in which the lead-tin overlay is replaced by lead-indium. The overlay thickness is roughly the same, but the two metals are applied separately, the lead being deposited first and the indium being applied afterwards by a diffusion process.

Carburation and Induction Systems

New Short Carburettors of the Downdraught Type

A NOTEWORTHY feature in carburation systems of the exhibits this year was the introduction, by British carburettor manufacturers, of very short downdraught types. This trend, which for several years has been evident in American design, is a result of the continual lowering of the bonnet line, which leaves much less room for the carburettor and air silencer. It might be thought simpler to return to the horizontal, or sidedraught, type of carburettor, but here much the same difficulties are encountered. The underbonnet space is being encroached upon more and more for the accommodation of heaters, screen washers and the like. To find space for a sidedraught carburettor with its attendant air silencer is not as easy as might at first appear.

In America, the almost universal adoption of the V-eight engine renders the use of a downdraught type of carburettor inevitable. In the compact V-eight engine designs, to which nearly all American manufacturers are committed, the middle



Carburettor and induction system on the Goggomobil T.300

On the Berkeley, an Amal carburettor is bolted to the single inlet port of the Anzani engine

A single Zenith downdraught carburettor of new design is now employed instead of the twin-barrel carburettor previously used on the Dyna Panhard de luxe model

of the vee is the only possible position for the induction system and the curburettor. In such a position the short multiple-barrel downdraught carburettor does provide a solution, at any rate for the present.

There has been much talk in recent years of petrol injection as a means of solving the problem of reduction of bonnet-line height, and this is the factor that is most likely to bring petrol injection forward as a production feature. Chevrolet has just announced that an injection system produced by the Rochester Manufacturing Co. Inc. is to be optional on the 1957 range of models—none of which, incidentally, was exhibited at the Motor Show. The reported power gains of the petrol injection system over the standard carburation arrangements are disappointingly small, being of the order of between 2 and 5 per cent.

Although petrol injection equipment for an engine of 285 b.h.p. has been placed in production it is unlikely that petrol injection is only just round the corner for engines of the much smaller capacity produced in this country. The smaller the power unit, the greater is the stress on economy in prime cost, and the more difficult are the technical problems to be surmounted.

As in previous years, all the American and Continental carburettors that were exhibited are designed on the open-choke principle. A number of the British cars are equipped with the S.U. constant-vacuum carburettor, although the majority of the large-quantity production models are fitted with carburettors of the open-choke type. In Great Britain, all carburettors manufactured by Zenith and Solex are open-choke instruments. Very few British cars exhibited are fitted with automatic chokes; on the other hand, every American car is so equipped. Several Continental cars also have automatic starting systems.

The Rootes concern, who pioneered the automatic choke in this country some twenty years ago, now fit hand-controlled stranglers on all the models they produce. So, also, do Armstrong Siddeley, who have employed the automatic choke on several models previously offered. Doubtless the reason for this change is that while in America petrol consumption is of minor consequence, in this country it is regarded as more important than automaticity of control. Such considerations do not, however, rule out the possibility of the automatic choke being re-introduced in Great Britain, if it is demanded on the export markets.

In general, starting systems on British open-choke carburettors are either the off-set strangler valve, with linked fast idle arrangements, or the separate starter-carburettor device as used on most Solex instruments. On the S.U. constant-vacuum carburettor, the method of withdrawing the jet sleeve from the needle is unaltered, and a linkage for opening the throttle, as with the open-choke instruments, is retained. A few car manufacturers exhibited models equipped with the S.U. version of the automatic choke. This takes the form of a small auxiliary carburettor feeding rich mixture into the induction tract, and is operated by a thermostatically controlled electric switch. Nearly all open-choke carburettors are fitted with automatic devices for metering lean mixtures during part-throttle operation, and for enriching the mixture to give maximum power. These devices are operated either mechanically or by induction depression. Accelerating pumps are also commonly incorporated.

Continental carburettor designs show a distinct trend towards the compound carburation system, in which two or more throttle barrels are employed. In most schemes, the primary throttle barrel performs in the usual manner, but the secondary one is brought into action either mechanically or as a function of manifold depression. This follows the development in the United States of the four-barrel instrument on a number of V-eight engines, with two throttle barrels in action all the time, the other two barrels coming into operation when high power output is required. It would appear that this scheme is a natural development of the open-choke type, and there seems a likelihood that its adoption will become more widespread.

The wide variety of induction manifold designs exhibited by the car manufacturers continues to arouse interest. No unamimity is shown either as to cross-section or layout of the induction tract. Some tracts are square or rectangular in cross section, others are round or a combination of both forms. In a number of systems, the gallery tract is turned

sharply through 90 deg to the cylinder head ports; in others it turns in a gentle sweep. Some designers employ coolant heat to warm the mixture, others employ exhaust heat, with or without a thermostatically controlled flap valve to direct the gases round the hot spot when the engine is cool.

A popular arrangement for the conventional four-cylinder engine is a two port-branch induction manifold with the inlet ports siamesed in the cylinder head, although a few manufacturers prefer to use the four port-branch induction tract with separate inlet valve ports in the head.

On six-cylinder engines, there are three conventional induction arrangements, and examples of each were to be found among the exhibits. These are: first the use of a three port-branch induction system, with the inlet ports of cylinders siamesed in pairs; second, a four port-branch induction layout with the outer inlet ports separate and the two inner pairs siamesed; and a six port-branch induction manifold with six separate inlet valve ports in the head. In a few instances, a combination of the last two layouts has been adopted.

The V-eight engines—mostly American—all have the now familiar central casting almost filling the angle between the cylinders. This casting incorporates cross-over induction tracts, together with exhaust hot spot channels and, in some, the water outlet to the radiator. The fuel is metered by a twin-barrel or four-barrel carburettor, each barrel or pair of barrels supplying a tract leading to two inlet valve ports in each cylinder head. The tracts cross at different levels, so the casting is most complex. In many installations exhaust gases are passed from the exhaust manifold of one bank through channels in the casting, around the hot spot of the riser T-junctions, and across into the exhaust manifold of the opposite bank. A thermostatically controlled heat valve is generally arranged on one exhaust manifold. It deflects the maximum quantity of exhaust gases round the hot spot when the engine is cold, and reduces this flow when the engine is hot. Thermostatically controlled, exhaust-heated hot spots are used almost universally on American exhibits, but few British and Continental cars are so equipped. Some examples of British models incorporating this feature are the new Hillman Minx, Vauxhall, and Ford Anglia and Prefect.

On European engines, silencers and filters of the oil-bath air cleaner pattern are gaining in popularity, and here again the lowering of the bonnet line sometimes introduces difficulties. On some American V-eight engines the dry paper and element type of filter is becoming popular with designers; it is usually of annular form and practically envelops the carburettor, thus saving space above.

A newcomer to the Earls Court Motor Show, the Bavarian Goggomobil, is an example of the trend towards the introduction of very small cars. Its engine, which is at the rear, is a parallel twin-cylinder, two-stroke unit manufactured by Hans Glas G.m.b.H. The whole installation is of remarkably neat and compact design. This engine is of 293 cm³ capacity, and is air-cooled by a centrifugal fan ducted to the engine cylinders. A Bing horizontal carburettor supplies the mixture through a small two port-branch induction manifold, the outlet ports of which are bolted directly to the engine cylinders.

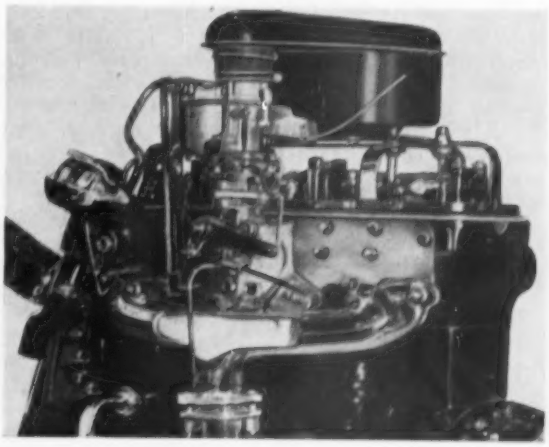
Also exhibited for the first time was the British Berkeley, another miniature car. In this vehicle the engine, which is in front, is an air-cooled, twin-cylinder, two-stroke Anzani unit of 322 cm³ capacity, producing 15 b.h.p. at 5,000 r.p.m. Carburation is effected by a motor-cycle type horizontal carburettor, of Amal design, which is attached to a port in the cylinder block. The mixture passes to a rotary valve in the engine crankcase. A small, disc-type air silencer is fitted to the carburettor.

The Panhard Dyna De Luxe, although equipped with an air-cooled twin-cylinder engine, is in an entirely different category from the two examples previously mentioned. Its power unit is of 850 cm³ capacity and is of the four-stroke cycle, horizontally opposed, twin cylinder layout, installed under the bonnet in the conventional manner. The induction system is of the design commonly employed on engines of this type. A long induction gallery connects the two inlet valve ports with the carburettor, which is mounted above the centre of the engine. In previous versions, a twin-barrel downdraught carburettor was fitted, but currently a Zenith single downdraught carburettor feeds a cast iron riser T-piece. Bolted to the two horizontal outlets of this T-piece are the two steel tubes that form the induction galleries. These tubes, which are flanged at each end, lead down to the inlet valve port of each cylinder. The riser T-piece is jacketed for the hot spot, and exhaust gas is fed into the jacket by means of two large diameter steel tubes, attached at one end to flanges on the hot spot casting and at the other to an exhaust pipe from each cylinder, underneath the engine.

The new Sunbeam Rapier has twin, Zenith downdraught carburettors. A noteworthy feature of these units is their low height

The carburettor, a Zenith 36-WI, is an example of the new, very short, downdraught carburettors, which will be described in greater detail in a subsequent section of this report. An accelerating pump is incorporated, without an economiser system, because the induction characteristics cannot take advantage of such a device. Starting is effected

Solex downdraught carburettor and the manifold arrangement of the Rootes engine in the Singer Gazelle



A long air silencer tube is fitted to the air cleaner of the Borgward engine; the whole induction system arrangement is noteworthy for the neatness of its design and layout

by an offset-mounted strangler valve, with interconnected linkage to the throttle for fast idle. A circular air filter is fitted to the intake mouth of the carburettor, the air intake orifice of the filter having a rectangular cross section, and the whole is so arranged that the filter can be turned to take cool air from the front in summer and warm air from the rear in winter. The mechanical fuel pump is located on top of the engine crankcase, immediately in front of the carburettor, and the petrol pipe, as on many Continental models, is of plastics material.

The new Renault Dauphine presents examples of several novel features. In the main, the engine follows the design of its predecessor, the model 750, very closely, but has a capacity of 845 cm³. As before, the induction and exhaust manifolds are on the left-hand side of the vehicle, the induction manifold being a separate aluminium casting. Of two port-branch design, it feeds siamesed inlet valve ports in the cylinder head. The gallery is of circular cross section, and curves inwards to the cylinder head ports with easy bends.

Heat for the mixture is supplied by a thermostatically controlled valve in the exhaust manifold. This valve directs hot gases up and around the induction riser T-junction when the engine is cold. The axis of the spindle of the offset heat valve lies in a vertical plane parallel to that containing the axis of the engine crankshaft and the coiled bi-metal thermostat spring is placed on a protruding end of the spindle at the rear. Unlike almost every other version of this device, the usual balance weight, attached to a protruding end of the spindle on the opposite side, is omitted.

It is surprising to find the carburettor of so small a vehicle fitted with an automatic choke or starter valve. A thermostatically controlled starter valve is provided inside the Solex carburettor, as distinct from the strangler valve or choke which is usually associated with automatic choke devices, particularly on American cars. The device incorporates the American type of hot air control for the temperature factor, air being taken from the carburettor intake by means of a small bore copper tube down to a stove located in the exhaust manifold casting close to the heat-control valve. This ensures that clean air only is being taken into the engine. From the stove, another small bore copper tube takes the now heated air up into a small circular thermostat box on the outside of the carburettor, and thence by another channel into the carburettor air passage.

In the American type of automatic choke the thermostat spring operates an offset strangler valve, but in this instance the spring controls the position of a piston valve which, in turn, governs the quantity of mixture admitted to the engine for cold starting. The carburettor, which is equipped with a mechanically operated accelerating pump, has the unusual feature of a nylon bush at one end of the throttle spindle.

Now a product of the Rootes Group, the new Singer Gazelle made its first appearance just before the Motor Show. The 1,497 cm³ power unit differs little from the previous Singer Hunter model, having a single overhead camshaft and a modified pent-roof combustion space. The camshaft operates the inclined valves through rockers at each side, and an unusual feature of such an arrangement is that both the inlet and exhaust manifolds are on the same side of the engine. The induction tract is cored within the cylinder head on the left-hand side, and ports lead down to the inlet valves located on the same side. From the exhaust valves, on the opposite side, the gases pass across the head through long ports to the other side, where the exhaust manifold is attached.

Cast integral with and on top of the exhaust manifold is the induction riser. This tract turns downward and inward to feed the main induction gallery inside the cylinder head. There is thus an ample hot spot for heating the mixture, but in really hot weather there might, conceivably, be a surplus of heat. A recess in the bottom of the tract under the riser provides a well, from which a manifold drain pipe is taken.

A Solex downdraught carburettor supplies the mixture, and a large metal shield is mounted in front of the carburettor, presumably to divert from it the cool fan-draught. An AC oil bath air cleaner is located above the rocker cover, the extension of the cleaner fitting over the carburettor intake. A single air silencing tube projects from the front of the air cleaner body.

Introduced earlier in the year and exhibited at the Motor Show for the first time, the new Ford Consul and Zephyr

The air cleaner, downdraught carburettor and the induction and exhaust manifold layout of the Skoda engine

models are each equipped with versions of one of the two new types of Zenith carburettors. Designated as the 34-WIA and the 36-WIA, the numerals refer to the sizes of throttle employed on the Consul and Zephyr respectively. These double-venturi instruments are interesting examples of the current trend towards very short downdraught carburettors, and although only 4¼in high, embody all the refinements associated with modern carburettor design.

These include an anti-percolating emulsion system similar to that employed on American Stromberg carberuttors, suction-controlled elements to give economical cruising on lean mixtures, together with maximum power mixture for high power, and a mechanically controlled accelerating pump. Cold starting is effected by the conventional form of offset-mounted strangler valve with interconnected fast idle linkage.

Other features are the separate, very short throttle body to prevent icing in winter, and the thick, heat-insulating gasket between the throttle body and the main body. This gasket serves to prevent excess heat from reaching the main body and metering elements.

The economy system consists of a power jet by-pass, similar to that of the Zenith-Stromberg instrument, in which the economical cruising mixture is metered by the main jet; the richer mixture necessary for high power is supplied by the by-pass jet. Here, the by-pass jet is controlled by a suction-operated diaphragm, held in the downward position by a spring. At part-throttle cruising, when the induction depression is high, the diaphragm is held away from the by-pass jet valve so that all metering is then effected by the main jet. When the throttle is opened wide for high power the induction depression falls, and the spring forces the diaphragm down to open the by-pass jet valve, so allowing the extra fuel to pass into the emulsion system.

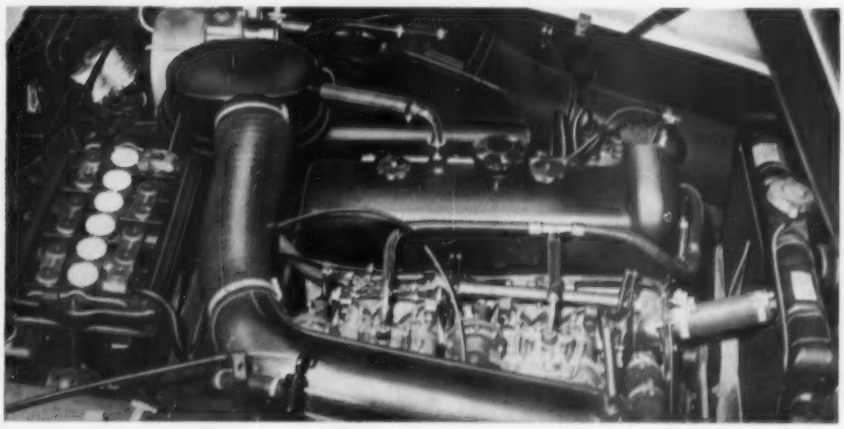
The accelerating pump is mechanically operated by linkage from the throttle spindle, and the pump jet is relieved of engine depression by an air bleed device connected to the main float chamber vent. Provision is made for varying the amount of fuel discharged by the accelerating pump. The pump link can be placed in one of the three holes in the pump drop arm, and by changing the position of the link, the pump stroke can be either long, medium or short.

Ford have retained the simple cast aluminium induction manifold and the steel tube exhaust manifold which have been used on the Consul and Zephyr models for several years. On the Consul, now a larger engine of 1,703 cm³ the induction tract is of the two port-branch pattern, feeding siamesed inlet valve ports in the cylinder head. The cross section of the main gallery is D-shaped, with the flat of the D forming the base of the passage, and the galleries on either side of the riser bend sharply inwards to the cylinder head ports. Following earlier Ford practice, the exhaust manifold has four ports, and is composed of a length of steel tube, blanked at one end, and having four rectangular orifices which correspond to the exhaust ports in the cylinder head. A semi-circular groove is machined in the head along the line of the exhaust ports, and in this groove lies the exhaust tube, secured by a number of pressed steel clamps.

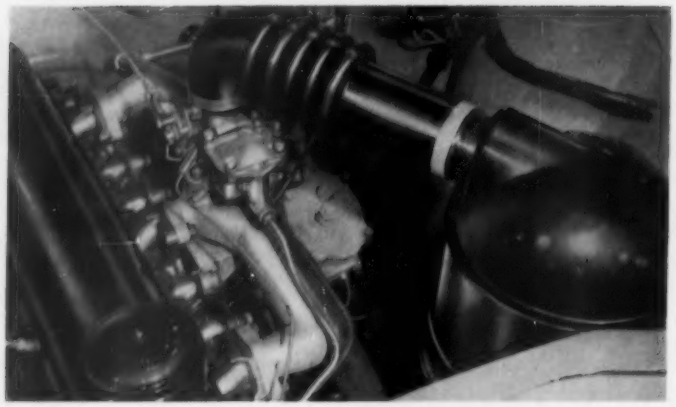
The hot spot does not look very effective but doubtless serves the purpose. The induction tract is placed above that of the exhaust, and the induction manifold casting carries a downward extension, hollowed to fit the exhaust manifold tube, over which it is clampred. This is the only heat path from the exhaust manifold to the induction tract. The short length of the riser to the induction manifold is dictated, no doubt, by the under-bonnet space. There is, however, a T-type AC air silencer, the outlet of which fits directly over the air intake of the carbutertor. As in the Zephyr, the fuel pump is a mechanical one, operated by the camshaft on the left-hand side.

Exhibited for the first time last year, the Sunbeam Rapier was then equipped with a single-carburettor system, employing a downdraught Zenith-Stromberg DIF-36 instrument. On the new R-67 model, the carburation system has been entirely re-designed to incorporate twin downdraught Zenith carburettors of the new short 36-WIP pattern. Previously the cylinder head had four separate inlet valve ports, fed by a twin gallery induction system similar to that fitted to the Sunbeam 90 models. Currently it has the same form of separate inlet valve porting, but in this instance the ports of cylinder pairs 1 and 2, and 3 and 4, are fed by two separate induction castings. Each takes the form of a siamesed tract, which separates before the riser and sweeps downwards from the carburettor and inwards to the cylinder head inlet ports, the bifurcation taking place about the middle of the 90 deg change of direction. The castings are of aluminium.

A contact hot spot with the exhaust manifold below is arranged by mounting the induction tracts upon two platforms integral with the exhaust manifold casting. The contact area is very small, and the arrangement bears every indication of careful design and development. Each induction casting has three short legs, two of which are in contact with the hot spot platform below, the contact area of each leg being little more than half a square inch. In order to prevent excess heat from reaching the undersides of the induction tracts, the hot spot platforms are covered with a heat-insulating sheet of moulded asbestos. As is



On the Mercedes-Benz 190SL, the two twin-barrel Solex carburettors have compound throttles governed by large suction-diaphragms



A three-port induction manifold is employed, in conjunction with the latest Zenith carburettor, on the Ford Zephyr. The air cleaner is mounted separately on the vehicle

usual with twin carburettor installations of this character, a balance pipe is provided, in the form of steel tubes joining the two induction castings at a point just below the carburettor flange joints and above the point of bifurcation. The tubes are connected by a short length of rubber hose and secured with Jubilee type clips.

The chief difference between the 36-WIP carburettor and the 36-WIA model previously described, lies in the absence of the economiser system, the metering requirements of the engine being such that no benefit can be obtained from these elements. The accelerating pump is retained however. The throttles are controlled by a layshaft mounted on brackets attached to the two induction manifolds, and the stranglers are operated by a cable coupled to the foremost of the linked strangler levers. An oil-bath air cleaner of the AC FP type is mounted above the rocker cover. Its outlet fits over an opening in the connecting piece joining the two carburettor air intakes. This connecting piece is fabricated in sheet metal, forming a box section of shallow rectangular shape. This design, doubtless is employed to reduce the overall height of the carburation system in order to provide clearance under the bonnet; the arrangement is neat and effective. As in the previous Rapier model, the fuel is supplied by an AC mechanical fuel pump located on the left-hand side of the engine crankcase.

Volvo exhibited two models, one of which, the 1,600 cm³ Amazon, is equipped with another new type of Zenith carburettor. Known as the 34-VN, this is a very short downdraught instrument with a single venturi system, similar to that of the existing Zenith V-type models. In this instance, the emulsion block, instead of being on the outside of the float chamber, is inside, and is attached by screws to the inner vertical wall nearest the venturi. Both main and compensator jets are now in the bottom of the emulsion block, the object being to keep the jet and emulsion system cool.

The economiser system is of the air bleed pattern common to most V models with suction-operated diaphragm, and the accelerator pump now has a follow-up action to prolong the discharge. Cold starting is assisted by the usual form of off-set mounted strangler valve and linked fast idle device. Located on the right-hand side of the engine, the induction and exhaust manifolds are of iron, and are cast integrally. The induction portion is of two port-branch design, feeding siamesed inlet valve ports in the cylinder head. It has a circular cross section and is located above the exhaust, the tract being formed in one smooth curve. Junction with the four port-branch exhaust manifold below is made by two thick webs, and there should be ample heat to warm the mixture in cold weather. It is evident that the system has been designed to cater for Swedish winter conditions.

Developed by the Volvo concern, the air silencer is a long cylinder having an elliptical cross section, the outlet of which fits over the carburettor in the middle, after the fashion of the AC T type silencer. It would appear that there has been experience of fuel running down the suction advance tube from the carburettor into the section advance diaphragm chamber, for the tube is looped upwards for some 3in on leaving the carburettor. A similar, but more elaborate, fuel trap is fitted to some Austin models, in the form of a small cylindrical chamber mounted vertically.

Also exhibited was the Volvo Sport, equipped with a smaller engine of 1,420 cm³ and fitted with twin S.U. semi-downdraught carburettors. These are mounted in the now conventional manner, each carburettor feeding its individual inlet valve port by way of a short riser casting. These two castings are in communication through a large-bore balance tube. Fitted to the air intake of each carburettor is a disc type air filter.

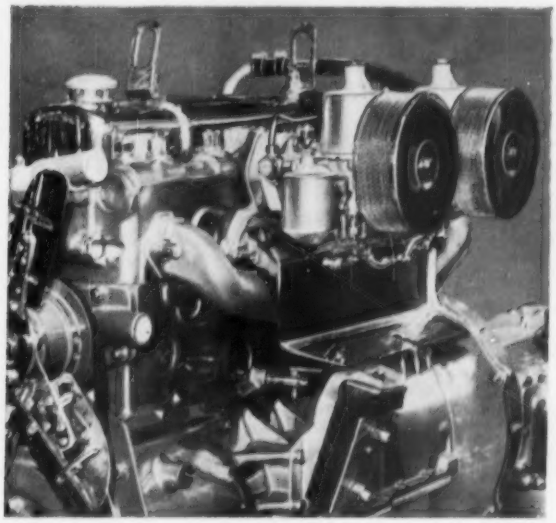
Both the Vauxhall models exhibited—the Wyvern and the Velox—were equipped with the new Zenith downdraught 34-VN carburettor, already mentioned in connection with the Volvo Amazon. On the Wyvern the two-port induction manifold with siamesed inlet ports is retained, together with the thermostatically controlled heat valve for the hot spot. The three port-branch induction tract has long been a feature of the Velox power unit, and this has not been altered. On both models, the cross section of the tract is D-shaped; continuing long-established Vauxhall practice.

Conventional lines are followed in the design of the four-cylinder Skoda 440 carburation system. Arranged on the right-hand side of the engine, the two port-branch induction is of aluminium and is located above the exhaust. A contact hot spot between bosses on both castings providing the necessary heating of the mixture. The induction tracts from the carburettor riser junction curve inwards to the cylinder head ports, which in turn lead into the siamesed ducts connecting with the inlet valves. A manifold drain tube is taken from a point in the floor of the induction tract below the carburettor riser. The downdraught type carburettor is surmounted by a long cylindrical air silencer. Fuel supply is by a mechanical fuel pump arranged on the left-hand side of the engine crankcase. Similar in appearance to some Solex models, the carburettor is produced by Pal—the section of the Skoda organization which manufactures components.

On the new Standard Vanguard Sportsman a twin carburettor installation is employed. The power unit is similar to that used in previous Standard Vanguard models, having a swept volume of 2,088 cm³. On the Standard III model a single Solex downdraught carburettor with a four port-branch induction manifold is fitted, but twin diaphragm type S.U. instruments are installed in the Sportsman. The arrangement closely follows the lines of the Triumph TR3, the twin S.U. horizontal carburettors being inclined at an

angle of some 30 deg from the horizontal, so that they become, in effect, of semi-downdraught type. A four port-branch induction manifold of aluminium distributes the mixture, the carburettors being located between the port branches of cylinders numbers 1 and 2, and 3 and 4. The portion of the tract between the two pairs of branches forms the balance channel.

Both float chambers are inboard, so that the chamber of the front carburettor is to the rear, while that of the rear carburettor is to the front. The air intake is formed by an aluminium casting shaped like an inverted T, the two arms of the T being attached to the air intakes of the carburettors. An AC oil bath air cleaner of the FP pattern is arranged above the rocker cover, the extension of the cleaner being connected to the air intake casting by a short length of



Two S.U. horizontal carburettors are used on the Austin-Healey Six

rubber hose. Two external silencer tubes, located some 90 deg apart and both pointing towards the front of the engine, conduct air to the cleaner.

Fitted with two 40 mm twin-barrel Weber horizontal carburettors is the 1,293 cm³ Alfa Romeo Giulietta Sprint Veloce, and each throttle barrel supplies its separate inlet valve port. For such small engines as these, separate 40 mm throttle barrels provide exceptional breathing capacity. A Y-piece casting joins the intake mouths of all four barrels, the air intake being connected to the air silencer by means of a length of rubber hose.

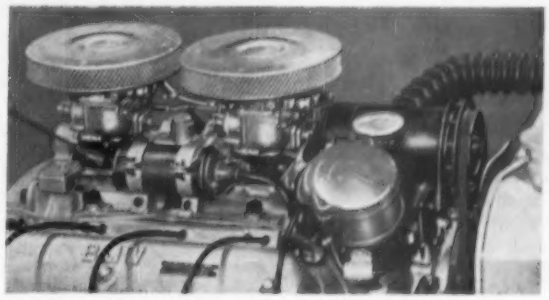
Yet another four-cylinder engine to be equipped with two large twin-barrel carburettors is the Mercedes-Benz 190SL. In this instance the carburettors are twin-barrel horizontal Solex PPH instruments, with compound throttles operated by large suction diaphragm systems. A departure from usual Solex practice, these carburettors are fitted with strangler valves and linked fast idle mechanism, as opposed to the well-known Solex auxiliary starting system. Covering the intakes of the four barrels is a aluminium channel casting connecting them with the air silencer on the right-hand side of the engine.

Like the Ford Consul four-cylinder engine described earlier, the Zephyr six-cylinder engine is also equipped with the new Zenith WIA carburettor, but in this instance it has a 36 mm throttle body bore, and is designated the 36-WIA. The induction tract is similar to that of the model exhibited last year, being of the three port-branch arrangement, and cast in aluminium. Located on the left-hand side of the engine, the layout is on what is known as straight-rake lines. The gallery is a straight tract turning sharply inwards at the ends to meet the siamesed inlet valve ports in the cylinder head, feeding cylinder numbers 1 and 2, and 5 and 6.

A development of the Austin A90 Westminster, the A105 is powered by a similar engine, but with twin carburettors and a higher compression ratio. It will be recalled that on the A90 Westminster a single downdraught Zenith carburettor feeds a two port-branch induction manifold, which in turn supplies mixture to a six-port gallery running the length of the cylinder head. On the A105 the external two port-branch manifold is replaced by two horizontal S.U. carburettors bolted directly to the flanges on the cylinder head to which the external manifold was attached. The internal induction gallery tract is located high on the left-hand side of the cylinder head, and the six inlet ports lead down from the gallery to the valves at a steep angle. A somewhat surprising feature of the system is the fact that some of the cylinder head holding-down studs pass right through the tract. Contrary to the arrangement of twin S.U. carburettors in many installations, the twin S.U. H4 instruments are not inclined to the semi-downdraught position but are arranged horizontally. Both float chambers are placed to the front of the engine, with the throttle lever controls at the rear. A cast aluminium air intake piece connects the mouth of the carburettors and is fed with air through a large cylindrical AC air cleaner of the oil-bath type, mounted vertically.

Also exhibited was the A95, an improved model of the previous A90. Here the single downdraught Zenith 42-VIS carburettor is retained, and supplies a two port-branch induction manifold. The carburettor and riser are placed low down to provide bonnet clearance. The circular-section induction manifold rises steeply on either side of the riser to meet the two ports in the cylinder head, which in turn feed the long induction gallery running the length of the cylinder head.

Another application of this 2·6 litre, six-cylinder engine



On the much-admired B.M.W. V-eight engine, two Zenith twin-barrel carburettors serve the induction system, which is neatly housed between the two banks of cylinders

was shown in the Austin-Healey 100. This installation is similar to that of the Austin A105 described above, the carburettors being twin S.U. horizontal instruments, fitted directly to the two manifold ports in the cylinder head. A flat, disc-type air silencer is fitted to each carburettor.

While the Jaguar Mk. VIII engine is basically the same as that of the Mk. VII, modifications have been made to the induction and valve systems to improve breathing and performance. Certain features of the C-type cylinder head have been adopted for the Mk. VIII. Broadly it can be said that the original inlet valve porting of the Mk. VII is retained, but with the valves used on the C-type engine. Thus, the inlet valve is increased from 1⅝in to 1¾in diameter, and the exhaust valve from 1½in to 1⅝in diameter. In addition, the inlet valve seating has been altered from 30 deg. to 45 deg.

and the valve head face has also been changed from convex to concave form.

The induction manifold has been modified slightly. On the Mk. VII the six port-branch induction manifold is an aluminium casting, having jackets for heating the mixture which are fed with coolant by matching ports in the manifold casting and the cylinder head. On the Mk. VIII the jackets in the manifold castings are retained, but these are now fed with coolant by a separate aluminium manifold, which is bolted to the induction manifold with flanged joints. Mixture is supplied by twin S.U. 1¾in HD4 horizontal carburettors. There is a separate exhaust system for the front and rear sets of three cylinders, each with its own exhaust manifold, exhaust pipe and silencer.

Radical alteration to the entire carburation system has been made in the Austin Princess. Now known as the Austin Princess Mark IV, this supersedes the previous version, designated A135. On the A135, the overhead-valve cylinder head porting arrangement was such that both inlet and exhaust ports were located on the left-hand side of the engine, the inlet valve ports being siamesed. On the new model a redesigned cylinder head has the exhaust valve ports on the left-hand side of the head and the inlet valve ports on the right. The inlet ports are now separate for each cylinder. A long induction manifold feeds the six inlet valve ports, the gallery tract being partitioned in the middle to form two separate galleries, one for the front three cylinders and the other for the rear three. The tracts are rectangular in cross-section. There is a balance orifice in the partition—a common practice with this arrangement.

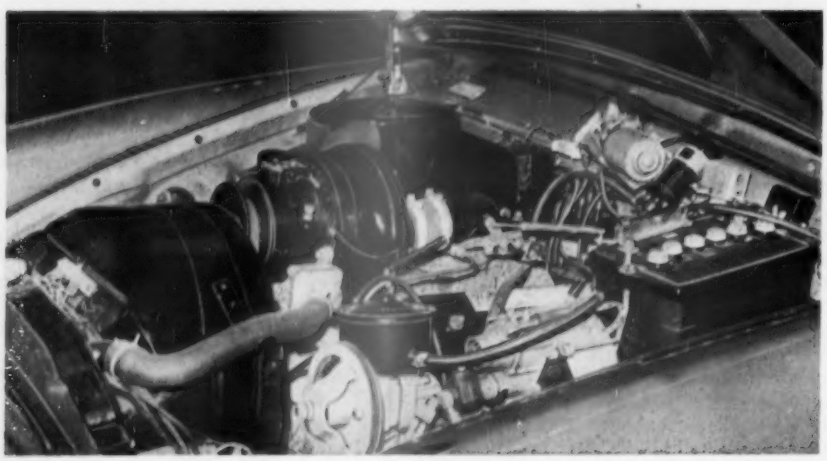
Twin S.U. carburettors, inclined to the semi-downdraught position, feed the front and rear gallery tracts. Care has been taken to correct the slope of the two galleries for the transmission angle of the engine, so that the floor of each tract is parallel with the ground. Each tract is fitted with a drain pipe. Coolant heat is provided, the gallery tracts being jacketed along the inner and bottom walls. Coolant is fed into the jackets directly through ports in the cylinder head, the feed back being by means of an external pipe. A Y-piece duct of aluminium connects the air intakes of the two carburettors to a long cylindrical air silencer, which is mounted longitudinally above the rocker cover with the air intake openings at the front.

Arranged on the right-hand side, the exhaust manifold system is formed of a single casting, although the tract is divided into two, for the front and rear groups of cylinders. From each of the two exhaust tracts a downpipe leads back to the two individual exhaust silencers, from which each system has its own tail pipe.

Twin downdraught compound carburettors are a feature of the Mercedes-Benz 220S. This 2·2 litre six-cylinder engine has a six inlet port cylinder head, and both inlet and exhaust valves are on the right-hand side. There are two separate induction manifolds, each with its own carburettor, one feeding the front three cylinders and the other the rear three. The hot-spot arrangement on the 220S warrants examination, in view of the tendency to consider it beneficial to run induction manifolds cooler than hitherto. Like the induction, the exhaust manifold system is composed of two separate castings, one each for the three front and three rear cylinders. What is interestung is the fact that, in a high-performance engine, thermostatically controlled heat valve hot spots are employed on each of the two manifold systems. The heat valves follow the usual pattern, with an offset-mounted valve plate in the exhaust passage to direct the hot exhaust gases around the riser junction when the engine is cold. Each valve is controlled by a bi-metal thermostat spring fitted to one end of the valve spindle, with the usual counterweight at the other end.

This air cleaner on the Nash Ambasador completely encloses the carburettor and is a good example of the all-enveloping type that is common on American V-eight power units

Owing to the delay in announcing 1957 models, there was little of outstanding interest in the American models exhibited. Noteworthy, however, was the Studebaker Golden Hawk, for which high performance claims were made. It has a V-eight engine of 4736 cm³ with a variable-speed, McCulloch supercharger. The four-barrel downdraught Stromberg carburettor is enclosed completely by a casing which seats on a large rectangular flange cast integral with the induction manifold, and the supercharger delivers air into this casing. The supercharger itself is mounted over the front of the engine and is driven by a belt. The speed of the supercharger is controlled automatically by a variable-diameter belt pulley.



On the Studebaker Golden Hawk, the McCulloch centrifugal supercharger delivers the air through the carburettor, which is completely enclosed and sealed

TRANSMISSION

Increasing Popularity of Overdrive, Semi-automatic, and Fully Automatic Systems

THE most important trend among British models at this year's Earls Court Show has been the further introduction of automatic and semi-automatic transmissions, in response to the demand for greater ease in driving. Models equipped with such devices number little short of twenty, and their adoption is of great importance to meet competition in overseas markets, especially in Western Europe. In America the fully automatic transmission is already well established, and therefore the appearance of similar equipment in a growing number of large and medium size British models is likely to have a profound effect on sales in dollar markets.

It is evident that the trends suggested in these columns last year have been amply sustained. In addition to the increasingly wide adoption of Borg-Warner and Laycock de Normanville overdrives, the Borg-Warner and Hydramatic automatic transmission systems, and the Automotive Products Manumatic semi-automatic transmission system as optional extras, there are two new British automatic and a new British semi-automatic transmission. Of the former, one is designed by the Rover Co. Ltd., and the other by S. Smith and Sons (England) Ltd. The new semi-automatic system is the Newton and Bennett design which, as reported in the November 1956 issue of *Automobile Engineer*, made its debut as the Standrive on the Standard 6 cwt van at this year's Commercial Motor Show.

Clutches

For most cars the conventional friction clutch, such as the Borg and Beck, is still employed. It is usually of the single dry plate type, exceptions being miniature cars having motor cycle type engines and transmissions, such as the Berkeley, which has a wet three-plate unit, and a wet two-plate unit on the German Goggomobil T.300. The Berkeley, designed by L. Bond, who originated the Bond Minicar, is manufactured by Berkeley Coachwork Ltd., of Biggleswade, Bedfordshire; the Goggomobil is made by Hans Glas G.m.b.H., of Isaria-Maschinenfabrik, Dingolfing, Western Germany.

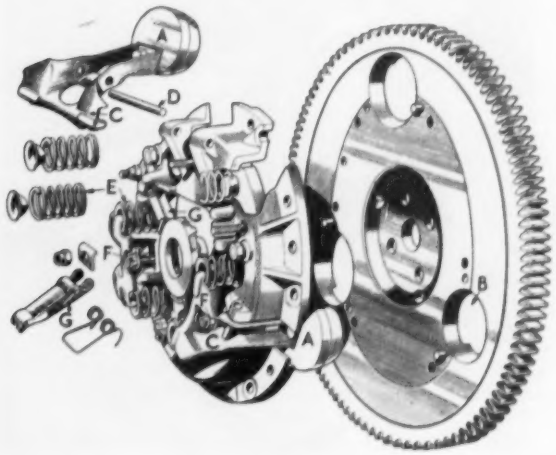
Hydraulic actuation of the conventional clutch is becoming increasingly popular for the reason that it is simpler and more effective than the complicated linkages required to isolate the pedal from the movements of a flexibly mounted engine and transmission.

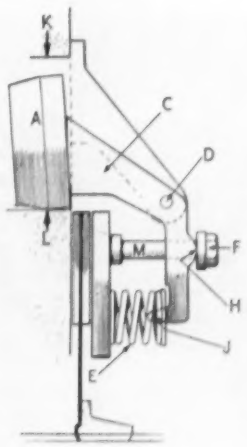
Two current centrifugal clutches are the Manumatic and the Newton units. The former is offered as an operational extra on the Armstrong Siddeley 236, Austin A50, Morris Oxford Series III, M.G. Magnette and Wolseley Fifteen-Fifty.

At present the Newton two-pedal Standrive is optional equipment on the latest Standard Companion estate car and Super Ten saloon. It is also available on the Family Eight model, which is the cheapest British car with two-pedal control. Referring to the illustration showing the action of the clutch, it will be seen that the use of only one set of springs is made possible by the unique design of the bob-weight levers, providing the lever with two fulcrum points, D and H. The weight A, integral with the lever C, is carried on a fixed pivot D, secured in the clutch casing, which rotates as one with the flywheel. From the pivot D, the lever C extends radially inwards to terminate in a formed shape, J, for permanent engagement with the spring cap. Actually, there are two formed shapes, each lever being mated to two springs of the set of six. Approximately mid-way between the pivot D and the spring-cap engagers J, and arranged on the rear of the lever, is a cam formation H which, when the clutch is disengaged, bears against a thrust washer supported by a nut F. This nut is on a stud M which, in turn, is carried by the pressure plate, the stud passing through a clearance hole in the lever. It follows, therefore, that under disengaging conditions, the spring urges the pressure plate and lever end J apart, and the lever, working on the fulcrum H, causes a reaction at the fixed pivot D, which withdraws the pressure plate from the driven plate. Limitation of withdrawal is effected by the weight A coming to rest on the inner face, L, of its housing hole in the flywheel.

During engagement, the clutch operates in two continuous stages, first taking-up the disengaged clearance between driven plate and pressure plate, and then lever C remains in contact with fulcrum point H; in the second, it moves away towards the pressure plate.

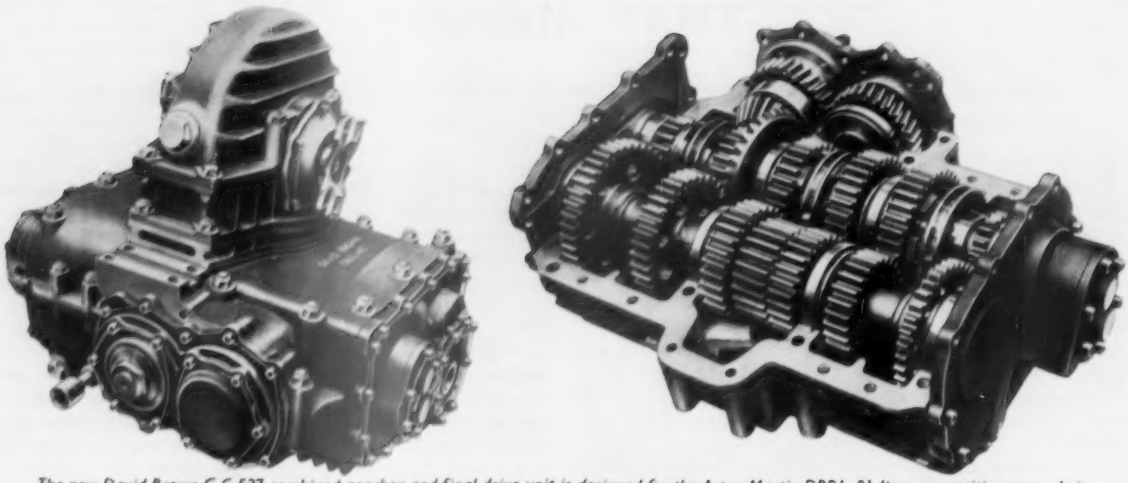
Starting from rest, centrifugal force arising from increasing speed causes the weight A to fly outwards, turning the lever C about its fixed pivot D and urging the pressure plate,





A Weight, B Weight housing, C Weight lever, D Fixed pivot, E Driving spring, F Reaction stud nut, G Withdrawal lever, H Lever cam, J Profiled lever ends, K Outer stop face, L Inner stop, M Reaction stud

Newton centrifugal clutch employed in the Standrive two-pedal control. The diagram on the right shows how engagement and disengagement is effected by one set of springs



The new David Brown G.C.537 combined gearbox and final drive unit is designed for the Aston Martin DBR1, 2½ litre competition car. It is shown on the left completely assembled and on the right with the top cover and final drive assembly removed

through the medium of the spring, towards the driven plate. The spring and the pressure plate, together with its stud M, move as one during the taking-up stage. Then, as soon as the pressure plate touches the driven plate, the continued travel of weight A towards the outer stop face K of its housing hole compresses the spring, relieving the load on F, and applies thrust through the spring to the pressure plate.

The clutch is withdrawn at speed by levers, not shown in the diagram, in the usual manner. The pressure plate is drawn back against the springs, leaving the weights in the "out" position.

Other than cars equipped with a fluid torque converter for automatic transmission, the only British exhibit employing a fluid flywheel coupling was the Daimler six-cylinder, 4½ litre DK400 limousine. Its gearbox is the familiar Wilson preselector, providing ratios of 4 : 1, 2·29 : 1, 1·51 : 1, 1 : 1 and reverse 5·55 : 1. It is controlled by a lever moving in a quadrant on the steering column. The remaining Daimler models, the six-cylinder 3½ litre One-O-Four and 2½ litre Conquest, are offered with either Borg-Warner automatic transmission or the Wilson box with fluid flywheel.

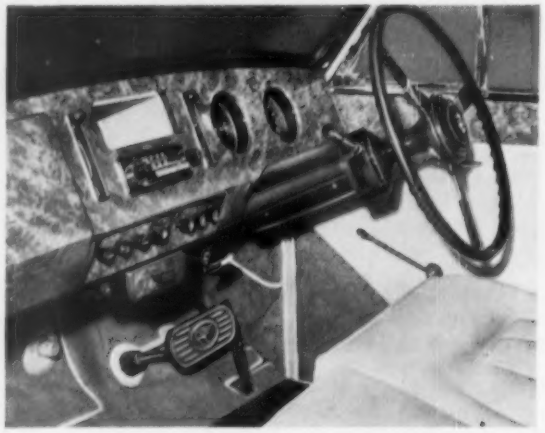
A notable foreign exhibit employing a fluid flywheel, single dry plate clutch with damper and a five-speed gear box with steering column control was the Italian Fiat 1900B. The synchromesh gear box for this model has direct drive on fourth.

A new British clutch is the electromagnetic arrangement developed by S. Smith and Sons (England) Ltd. It forms part of the semi-automatic or fully automatic transmission systems briefly described elsewhere in this article.

Gearboxes

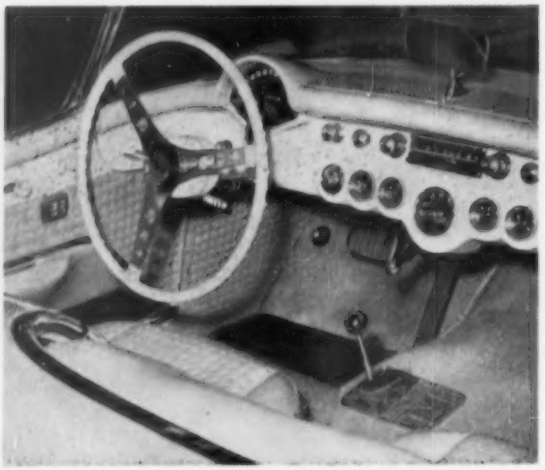
The three-speed gear box is still fitted to a number of cars. Among these, neglecting automatic transmission systems, are the new Berkeley, all standard Ford models, the Nash Metropolitan with a four-cylinder engine, the Morgan 4/4 Series II with Ford Engine and transmission, Renault 750 and Dauphine, the Volvo, Standard Vanguard, and all Vauxhalls. With the exception of a few five-speed boxes, such as those on the Fiat 1900B, Lotus Formula II, and the David Brown G.C.537 and S532 types, all other gear boxes have four speeds.

The David Brown G.C.537 and S532 gearboxes have been successfully employed in, respectively, the Aston Martin DBR1 competition car which made its debut at Le Mans



Above: The Austin Princess, with a body by Vanden Plas (England) 1923 Ltd. This is a typical example of a control layout for a vehicle equipped with the Hydramatic type automatic gearbox

Below: The Chevrolet Corvette is an example of the driving control arrangement employed in conjunction with the Powerglide transmission, which has a three-element torque converter



this year, and the streamlined, supercharged Austin-Healey Hundred Six which recently achieved 203·06 m.p.h. at Utah, U.S.A. To obtain a more favourable front : rear weight distribution for the Aston Martin, the G.C.537 type has been combined with the final drive, the whole assembly being mounted on the chassis. The drive to each rear wheel is transmitted by a shaft having two universal joints. Input to the gear box is through a pair of single-helical gears, and thence to the layshaft, arranged at right angles to the chassis, by means of straight-tooth bevels. The helix angle of the input gears is arranged so that the thrust balances that from the bevel pinion.

Spur gears take the drive to the mainshaft. First and second speeds are positioned to the right of the bevel wheel, and third, fourth and fifth, as well as reverse gears to the left. The final drive pinion is mounted centrally on the mainshaft, to mesh with the final drive wheel, arranged directly over the gear box, and the differential is incorporated inside the bevel drive. All gears are in constant mesh, and the various speeds are engaged by dog clutches except for reverse, which has a sliding idler gear.

Dry sump lubrication is employed, and both pressure and scavenger pumps are driven directly from the layshaft. Oil is fed through the layshaft to lubricate the bearings of the loose running gears, and ports are arranged in the selector rods to spray only those gears transmitting power.

Small modifications in overall ratios can quickly be made by changing the single-helical input gears. By inserting sandwich pieces between the main gear box and differential housing, the centre distance of the final drive gears can be altered, thereby enabling alternative gear sets to be used and the ratio changed.

The S532 gear box is a five-speed synchromesh unit with overdrive top. It is designed to accommodate rear, side or steering column control. Overall ratios are: fifth 0·825 : 1, fourth 1 : 1; third 1·95 : 1; second 1·73 : 1; first 2·7 : 1; and reverse 2·31 : 1.

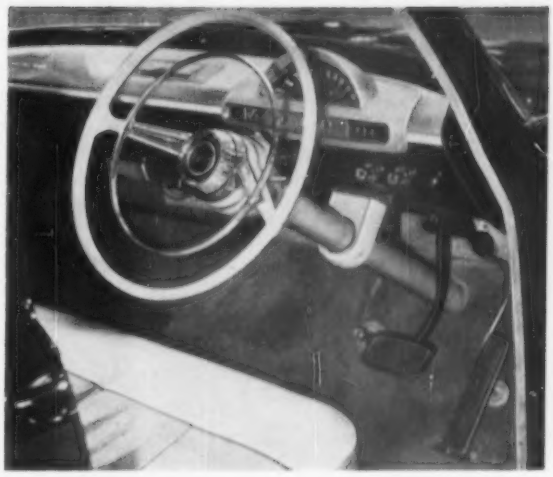
Overdrives

The increased popularity of overdrive units is truly remarkable. They are now standard equipment on a number of cars, both British and foreign, and offered as optional extras on many. Their application is almost universal, for they have been mated to all kinds of gearboxes ranging from the sliding gear to the fully automatic units.

Two makes of overdrive are most commonly employed. They are the Borg-Warner, now manufactured in this country, and the Laycock de Normanville. Both were reviewed in these columns last year. Two recent introductions are the Laycock de Normanville Type D, specially developed for cars of less than 1½ litre engine capacity, and a modified Lucas automatic control system for all types of Laycock de Normanville overdrives.

The Type D now brings the advantages of this all-British overdrive to the smaller family cars. By efficiently exploiting the high-speed characteristic of small engines, it is being accepted by manufacturers and motorists in this country as rapidly as the larger version. Already the Type D has demonstrated its dependability in successive arduous competitions on the Sunbeam Rapier, to which it is fitted as standard equipment.

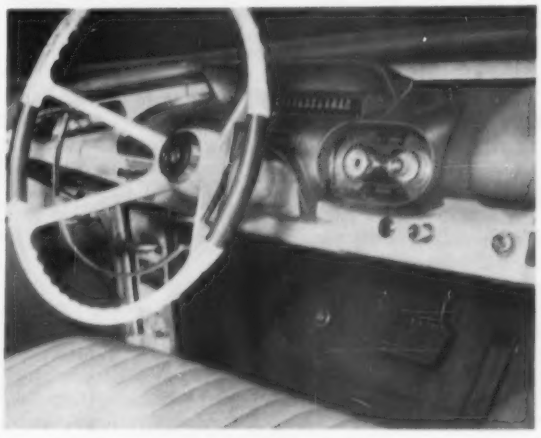
The Lucas automatic overdrive control ensures the maximum advantage being taken of the overdrive gear. Manual control involves extra thinking and work by the driver, and its full value is probably rarely obtained. With automatic control, sensitive to speed and throttle variations, the overdrive gear may be engaged for as much as 90 per cent of a car's mileage, depending on the transmission requirements. Thus savings in fuel and reduced engine wear are effected without conscious effort by the driver.

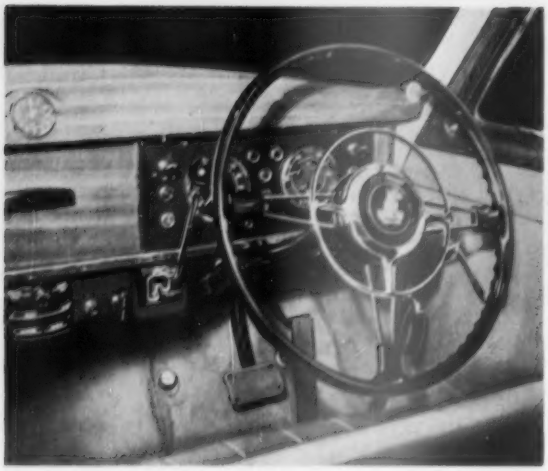


Ford Zodiac with the Borg-Warner automatic transmission, which is offered as an optional extra for this model and the Zephyr

The Citroen DS19 is equipped with semi-automatic transmission

The driving controls of the Mercury Montclair equipped with the Merc-O-Matic drive automatic transmission, which comprises a torque converter with a three-speed epicyclic gear train. The push-button selector for the transmission is on the left of the facia





The Rover 105R equipped with a Roverdrive automatic transmission. In this system, a torque converter is fitted in front of a vacuum-actuated single dry plate clutch. Behind this assembly is a synchromesh gearbox, giving one reverse and two forward speeds, and a fully automatic Laycock de Normanville overdrive unit

The kick-down switch for maximum acceleration when overtaking is retained with the automatic control, and provides an instantaneous change to direct drive by depression of the accelerator pedal beyond the position of normal maximum throttle opening. The throttle switch has, however, been modified. It is now a four-way rotary unit, linked by a simple lever to the throttle control mechanism. Its manner of operation and a diagram of the complete automatic control system is given in the section headed 'Electrical Equipment', later in this review.

The Laycock de Normanville overdrive can be set to operate on any desired gears in a gearbox within its torque capacity, whereas the Borg Warner is dependent on propellor shaft speed, and has a critical speed above which it can be engaged, regardless of the gear selected. In most three-speed applications, overdrive second provides a useful intermediate ratio between normal second and normal top, but when used in conjunction with a four-speed box with lesser gaps between ratios, little is gained by the use of overdrive in the indirect gears.

Three French makes, Citroen 2CV, Peugeot and Dyna Panhard, have four-speed boxes, in which fourth is an indirect overdrive. This scheme has been dropped for the Renault Fregate range this year, which now uses an ordinary four-speed box with direct fourth, combined with higher final drive gearing.

Automatic Transmissions

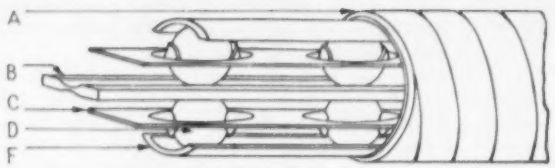
Apart from the Citroen DS19, with a conventional clutch and gearbox jointly controlled by hydraulic power and finger-tip selector lever, new cars employing semi-automatic transmission mostly use the Manumatic or the Standrive units referred to. In the medium to high price brackets most British and all American makes are either fitted with fully automatic transmission or offered with such as an optional extra.

In America automatic transmission is now almost universal. In Great Britain the development has grown rapidly, encouraged by the need to meet foreign competition. The system most employed on British cars is the Borg-Warner design with hydrokinetic coupling and epicyclic gear train. However, Austin fit the Hydramatic unit in their new Princess IV and Rolls-Royce are manufacturing it under licence for their vehicles. Some general information on the Borg-Warner system was given in last year's Show report and a detailed description was published in the September 1956 issue of *Automobile Engineer*.

The transmission system on the Rover 105R is called the Rover-drive. It comprises four units arranged in succession. These are: a three-element fluid torque converter; a vacuum-operated Borg and Beck dry single-plate clutch of conventional design; a two-speed and reverse synchromesh gearbox; and a fully automatic Laycock de Normanville overdrive. Hence, apart from the torque converter, the transmission consists of well understood units, quite easily serviced by a competent garage mechanic.

Driving control is by a lever, extending from the facia panel. It has only four positions: neutral, drive, low and reverse. A small push button in the knob of the lever releases the clutch, effecting positive interruption of the drive for gear engagement. In this way, converter drag at

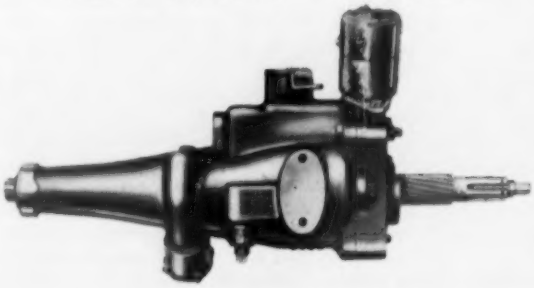
The gear shift lever of the Wolseley Six-Ninety is now on the floor instead of on the steering column, and a new safety steering wheel is employed

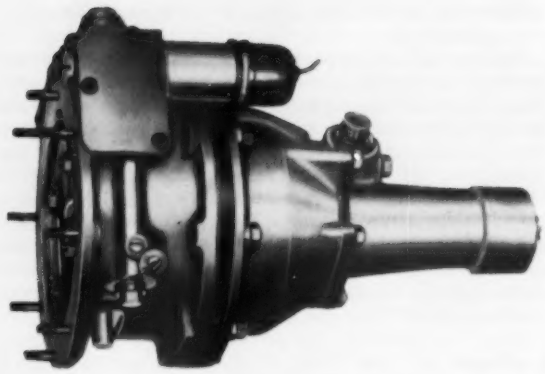


A *Armoured and braided cable casing,* **B** *Flexible stainless steel pull-push ribbon with opposed inner ball-tracks,* **C** *Flexible stainless steel ribbon ball spacer,* **D** *Hardened steel balls,* **E** *Fixed Flexible stainless steel outer ball tracks*

Above: Gear selector control cable on the Dyna Panhard de luxe

Below: The Borg-Warner automatic overdrive unit



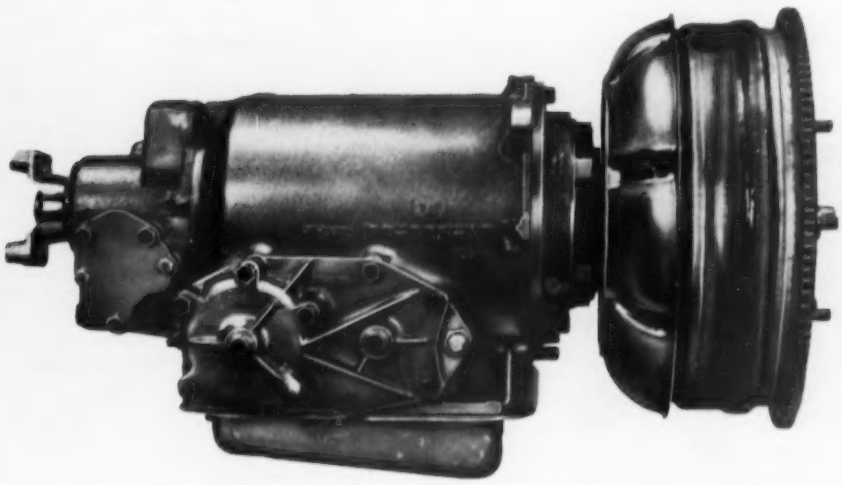


Latest version of the Laycock de Normanville overdrive, the Type D, specially developed for smaller cars; the Type A is still in full-scale production for use with engines of 2-3½ litre capacity

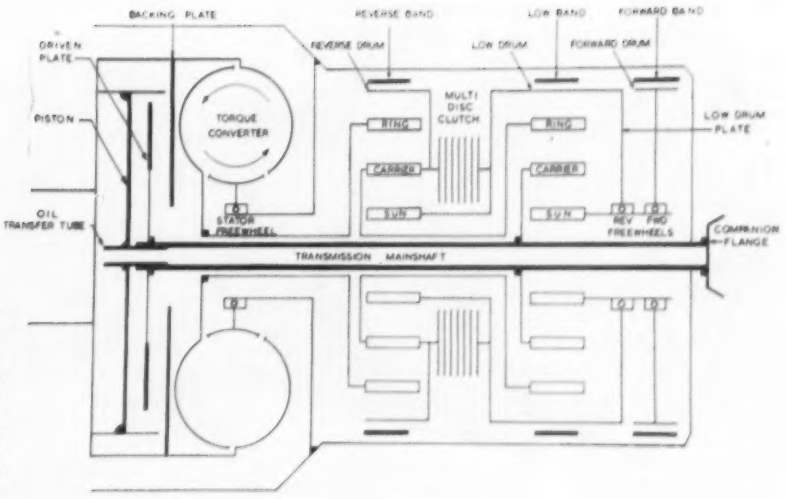
idling speed is prevented from interfering with gear engagement when the car is at rest, and changes from drive to low, or low to drive, are facilitated. In short, the clutch serves solely as a drive-interrupting medium, the work of taking-up the drive being effected entirely by the converter. Under normal conditions, the control lever remains in Drive, and the converter and the automatic overdrive attend to the rest.

The Smiths system has completed exhaustive prototype tests, both on the bench and on the road, and gives promise of becoming a satisfactory low-priced arrangement without such power losses as are associated with other forms of automatic transmission. It is designed in two guises; one is the semi-automatic Selectroshift, the other a fully automatic unit—the Autoselectric. Both systems are based upon a somewhat new application of the electromagnetic clutch, and can be completed by any form of gearbox. In the Smiths prototype designs, the gearbox is of the constant mesh layshaft type.

Originally, the principle of the clutch was patented in America by Jacob Rabinow. This involves the passing of a magnetic flux through a powder contained in an annular gap



Borg-Warner automatic transmission, incorporating a three-speed epicyclic gear assembly, torque converter and direct drive clutch



Diagrammatic illustration showing the layout of the Borg-Warner automatic transmission. Nominally this system gives one reverse and three forward speeds. However, the hydraulic torque converter coupling is used with the low and intermediate forward gears to give a smooth range of torque conversion from a ratio of 4·6 : 1 to 1·435 : 1. For high gear, a single plate clutch couples the engine directly to the transmission mainshaft

between the driving and driven members of the clutch, thereby consolidating the powder in a manner which exerts sufficient pressure between the members for the transmission of torque from one to the other. The powder is quite dry.

Pioneering work on this type of clutch was carried out by the Eaton Manufacturing Co., of Cleveland, Ohio, from whom S. Smith and Sons (England) Ltd., have acquired exclusive patent rights for all countries except North America. Following further developments by Smith, the clutch takes a very simple form, comprising a two-part, low carbon steel driving member, containing an insulated electrical coil, and a low carbon steel driven member. There are no pole formations of any sort, the coil being entirely enclosed and arranged to surround the driven member. Both driving and driven surfaces are fully cylindrical, forming a complete annular gap between them. When the coil is energized, a radially disposed flux is established across the gap, and this, in passing through the powder, produces the driving torque between the two members. The value of this torque is almost directly proportional to the excitation current in the coil.

The driven member is mounted on a hub, carried on a ball bearing housed in the cover attached to the driving member. The input shaft of the orthodox gear box makes spline engagement with the hub in the usual manner. Annular slip-rings on the outer surface of the cover convey the exciting current to the coil, the rings being fed by a brush gear secured within the clutch case. This case is flange-mounted to the engine after the manner of a conventional bellhousing and the gearbox is bolted to its rear end. At its forward end, the clutch is closed by the flywheel—much lighter than the standard version—which carries the starter ring gear in the usual way.

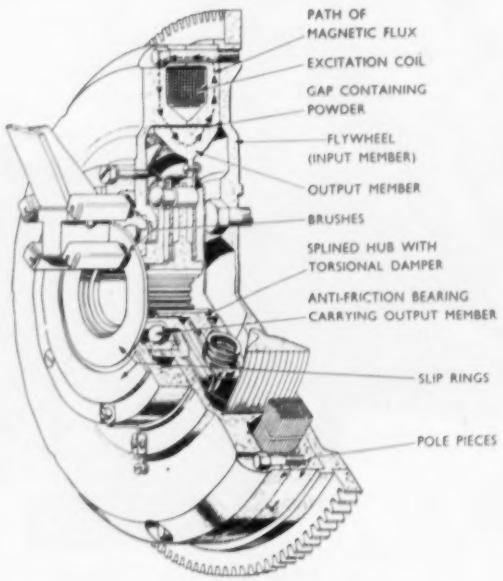
Little difficulty has been experienced in keeping the powder in the annular gap. While the clutch is rotating, this is achieved satisfactorily by the high centrifugal forces acting on the powder. When the clutch is stationary, the powder that might fall from top to bottom of the annular gap is prevented from reaching the clutch centre, where it could either escape or enter the ball bearing, by pressed steel shrouds or labyrinths. These are inclined, to catch any powder that falls vertically, and to guide it clear of the clutch centre to the lower region of the space between the driving members.

The intrinsic advantages of this new clutch are, firstly that operation is entirely electrical, so that controls are very simply grouped and installed; there are no mechanical linkages subject to wear or loss of adjustment. Secondly, torque is easily controlled, this being governed entirely by the value of the exciting current at any given moment. Lastly, the dynamic and static coefficients of friction between the powder and the driven members are identical, ensuring completely smooth judder-free clutch engagement. Further notes on the Smiths semi-automatic and fully automatic systems, and a diagram of the Selectroshift, appear in the section entitled "Electrical Equipment".

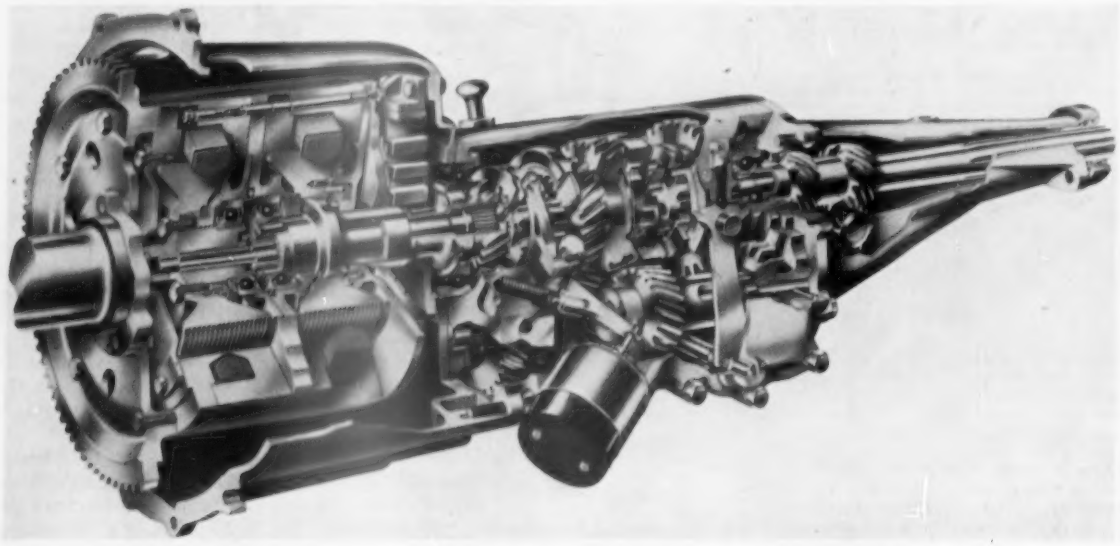
Controls

The most popular position for an automatic transmission selector lever is on the steering column. Notable exceptions

Diagrammatic illustration of the magnetic clutch employed in the Smiths semi-automatic and fully automatic transmission systems



Layout of the Smiths Autoselectric transmission, the key component of which is the electromagnetic clutch illustrated above



are the Chevrolet Corvette, with small central lever on the floor; the Chrysler Corporation's products and the Mercury Montclair, which have push buttons on the facia panel; the Packard Patrician, with convenient push-buttons on the steering wheel; and the British Rover 105R, with facia-mounted lever. On semi-automatic systems, the standard gear lever is universally retained, except on the Citroen DS19, which has finger-tip control above and behind the steering wheel.

An interesting trend in this country is the reversion to floor-mounted gear levers on the Morris Isis II, Wolseley Six-Ninety and Fifteen-Fifty. In the Isis and Six-Ninety, as on the Riley Pathfinder, the lever is now on the right-hand side of the driver's seat, leaving adequate room for three people on the front seat. The Fifteen-Fifty has a central change like that on the M.G. Magnette. On the Dyna Panhard, the gear lever is linked to the gearbox selector mechanism by an ingenious flexible control cable. Named the Flexiball it eliminates all backlash associated with ordinary mechanical linkages, requires no lubrication and greatly reduces production costs. It consists of an outer casing, similar to that of a speedometer drive cable, containing flexible ball tracks between which the actual control cable runs in ball bearings. The control cable is a flat steel ribbon, with sufficient cross-sectional area to allow for inner ball tracks of ample size. Two perforated steel ribbons, arranged one above and one below the control cable, serve as ball spacers. Movement of the cable is practically frictionless.

Propellor shafts and final drives

All American and most British cars continue to employ conventional final drives. An exception is the new Berkeley which has a roller chain final drive to the independently sprung front-wheel. The Rover T3 gas turbine car—a third prototype which is in no way a final design—employs a rear-mounted engine, and four-wheel-drive. A refinement on several American cars, including Packard, Lincoln, and Mercury is the fitting of a power lock differential.

Front Suspension and Steering

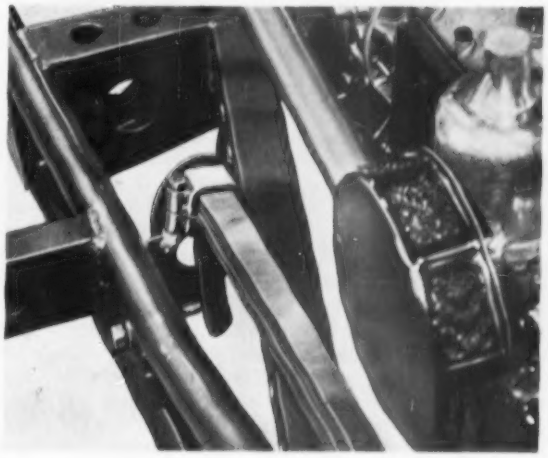
Recently Introduced Systems Indicate New Lines of Approach

THERE is, as yet, no indication that the example set by Citroen, over a year ago, in the adoption of their hydro-pneumatic system on the DS19 model, is being followed by other manufacturers. The superiority of this system over conventional suspensions in respect of the improved riding comfort and wheel adhesion, due to the maintenance of constant rate and static height irrespective of the load carried, is indisputable. The same suspension system is used for the cheaper version—the ID19—although operation of the steering, gear change, clutch and brakes from the central hydraulic system, has been discontinued.

The new Rover turbine car shows original thought on problems associated with the suspension of driven wheels. This four-wheel drive car employs a design covered by Patent No. 702454. In the front suspension, the drive shafts are universally jointed at both ends, and have no splined sliding members. Hence lateral loads are supported by the shafts, with the aim of overcoming the drawback of the resistance to sliding of a splined coupling when it is transmitting torque. The hub is carried in a long, fabricated kingpin post, and a single forward facing suspension arm is ball-jointed to the underside.

At the top of the post is a trunnion assembly, containing a plain bush to which is attached a triangulated arm. Together the arms provide longitudinal location and resist the canting couple. They have a large vertical separation to reduce bearing pressures. The coil spring and telescopic damper are combined as a single unit anchored at the lower end to the bottom suspension arm, the top mounting being on the scuttle-wing-valance structure. This principle permits suspension geometries other than that of the pure swing axle to be employed, at the same time discarding the splined coupling or pot type universal joint, with the attendent frictional interference with suspension movement.

A version of the Macpherson front suspension arrangement, as used by Ford and by Simca on the Vedette, was seen on the Allard Palm Beach. It is of particular interest as an example of the application of this system to a vehicle with a separate chassis frame. A single, wide-base, tubular wishbone, having rubber-bushed bearings at the chassis mountings, supports the lower end of the long, tubular, kingpin post, through the medium of a trunnion with a screw thread swivel bearing. Towards the upper end, the post enters a bronze bushed sleeve, pivoted to a bracket outrigged from the frame, which accommodates suspension and steering movements. Unlike the Ford layout, which has the damper integral with the king pin post, a separate telescopic unit is mounted between the bracket which carries the upper trunnion, and the forward arm of the wishbone. The Allard arrangement, of course, is more suitable for production in small quantities.



Screw adjustment for the laminated torsion bar on the new Allard

A laminated torsion bar, consisting of six leaves 1¼in wide by $\frac{1}{2}$in thick, is in board of the frame side member. A drop link, ball-jointed to the king pin post, operates a lever clamped to the forward end of the torsion bar and supported in a rubber bushed bearing on the frame. At the rear end of the torsion bar, the leaves are clamped and pivoted on the longitudinal axis of the bar. A small pendant lever, integral with the clamp, bears against a set screw for the adjustment of static height.

Vertical suspension loads do not have to be borne by the wishbone which, therefore, can be of a light construction,

The new front suspension for the Allard Palm Beach

and the steerings swivel bearing are similarly relieved of axial loads. For low speed manoeuvring this should make for lightness in steering, but with the mounting of the dampers on the wishbone the effect might be partly offset during rapid wheel displacements.

Generally, such three-point types of suspensions, with their widely separated, lightly loaded pivots, are well suited to the current integral chassis-body structure, and also point the way to a reduction in the number of chassis greasing points which require attention, or of rubber bushes that must eventually be replaced. Possibly superior to any in this respect is the sliding pillar front suspension of early origin as used by Lancia on their Aurelia and Appia and by Morgan, in which the spring medium, steering swivels and, in the case of the Lancia, the damping as well, are contained in a single unit rigidly secured to the chassis. In both makes, with the exception of one manual lubrication point on each side, the front suspension is lubricated with engine oil by the depression of a remotely-placed plunger, while steering joints are rubber bushed.

A comprehensive, centralised chassis lubrication system was seen on the Frazer-Nash Continental. This is the Enots design, in which front suspension bearings are supplied with oil through flexible hoses. Rover in their production cars continue their admirable stub axle reservoir, which requires topping up with oil at intervals of 9,000 miles only, and steering ball joints that are grease-packed and sealed for the duration of their useful life.

Often a study of racing car suspension reveals lessons in weight reduction. The Formula II Lotus is a case in point. In the front suspension of this car, vertical links with the lower screw thread trunnions and upper spherical joints of the Standard Eight are employed. The lower wishbones are of welded tube construction, and the single upper links, also tubular, are braced by the cranked ends of an anti-roll bar mounted transversely at the front of the frame. If this arrangement is adopted, it is preferable to incorporate it in the upper link, because the horizontal loads imposed upon it during braking are much lighter than those resisted by the lower wishbone. Rubber bushes at the attachment points of the bar to the link and at the inner pivot of the link accommodate the conflicting arcs of movement.

This inner pivot pin is extended forwards to provide a mounting for the Girling combined coil spring and telescopic damper unit. The lower abutment of the spring of this compact unit is integral with the inner sleeve of the damper, so that the lower bushed eye can be mounted, as in this application, near the apex of the lower wishbone. Hence, it is possible to use a smaller spring having a lighter static loading than if the spring were to seat at an intermediate position on the wishbone, which, in turn, does not have to be proportioned to resist large bending loads.

A further important contribution to the reduction of unsprung weight is the use of dished, cast magnesium alloy wheels with radial flutes to increase their rigidity. These wheels are secured to the hubs by six studs and nuts. In view of the increased life of current racing covers and the light weight—5¾ cwt dry—of the car, centre lock hubs for rapid wheel changing are unnecessary.

A new form of steering gear was introduced this year on the latest version of the Hillman Minx. It is manufactured by Burman. The usual box has been discarded, its function being performed by the two main components of the steering column. One of these components is an outer tube enclosing the second component—a shaft, at the lower end of which a worm is cut. The nut is integral with a long sleeve, into which the lower end of the shaft projects. A ball joint assembly on the end of the sleeve transmits the axial movements of the nut to a lever mounted on the upper end of a pivot pin. The axis of this pin is in a vertical plane and is normal to the transverse, inclined plane containing the axis of the steering column.

The whole assembly is carried by a bracket, bolted to the chassis-body structure. This bracket is bored to receive the lower end of the column outer tube, and is bushed to to form the bearing for the pivot pin that carries the lever. Mounted on the lower end of this pivot pin is a two-armed lever. One arm extends to the rear and is connected to the track rod, which is behind the engine, while the other end extends forward to receive the end of the steering rod that actuates the adjacent road wheel. Similar connections are

Transverse leaf spring front suspension on the Frazer-Nash Continental

On the Lotus Formula II racing car, the anti-roll bar is an integral part of the upper wishbone of the front suspension

made to an idler lever on the other side of the vehicle. To accommodate lateral displacement of the column, due to the movement of the steering arm about its pivot, a self-aligning bearing is employed to support the upper end of the inner component of the column in the outer component.

Power assistance for steering has gained further adherents among manufacturers of the larger cars. This is because the demand for ultra-light steering can be met only by such methods, unless directness of steering at high speeds is sacrificed. It is likely that within the next year or two, servo assistance will be applied even to some of the medium-size models. This is partly a result of the concentration of weight on the front wheels in many current designs: the forward movement of power units to increase passenger accommodation has not been accompanied by a corresponding weight reduction, or by a redisposition of components, to restore the balance. The use of smaller wheels, fitted with tyres of greater section, of course, tends to aggravate the problem.

Since the preceeding Earls Court exhibition, Rolls-Royce have developed their own power-assisted steering system to the production stage. The layout embodies an engine-driven, hydraulic pump, of Hobourn-Eaton manufacture, a control valve in unit with the Marles hourglass worm and roller steering gear, an oil tank and a double-acting hydraulic ram. The cylinder of the ram is pivoted on the front cross member of the chassis, and the piston rod is connected to a boss on a steering idler lever.

When the steering wheel is turned, the worm is displaced axially 0·008in–0·010in, causing oil under pressure from the pump to flow through a distributor to the ram. A piston attached to the worm shaft actuates a valve plate through a series of springs and plungers. The springs determine the effort exerted at the steering wheel rim at which assistance commences—this is one pound. Thereafter, effort and assistance are equal until an effort of 8 lb is applied, when assistance is provided at an increasing rate. The maximum steering wheel effort required is in the order of 12 lb during very low speed manoeuvring. Feel in the steering is maintained by the transmission of oil pressure from the thrust side of the piston to the control valve. This pressure tends to centre the valve plate. With this system it has been found possible to change the steering gear ratio from 20·6 to 1 to 18·7 to 1.

Rear Suspension

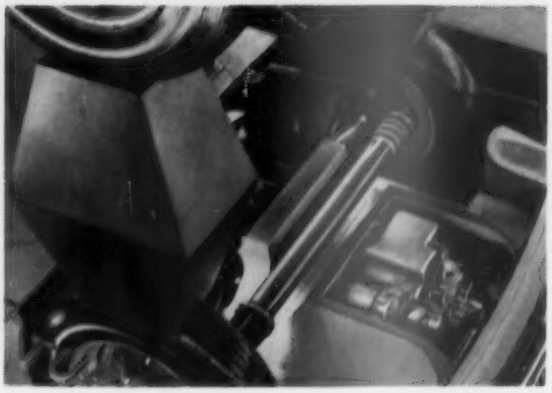
Advances in Detail; A Watts Linkage System Employed on a British Car

THE Rover T3 turbine car provided the only example at Earls Court of a radical departure from established practice in rear suspension. The drive shafts have two universal joints, but they are without splined sliding members, to eliminate the frictional resistance generated by such joints when transmitting torque—a similar layout is utilised at the front. Hence the shafts sustain lateral loads as in some swing axle designs, but in this instance they are used with an axle of the de Dion type.

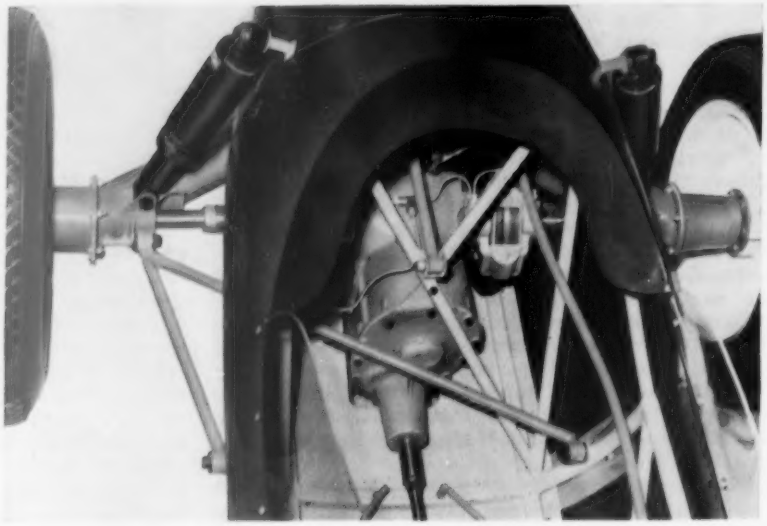
Longitudinal location of each hub carrier is by a Watts linkage having a rubber bush at each pivot. The combined coil spring and telescopic damper units are attached tangentially to the hub carriers, thereby utilising the rotation of the latter to give a slightly rising rate on bump movement. The axle tube, bolted to the hub carriers, is in two parts, jointed at the right-hand end. This is done by entering one part within the other and interposing a plain bush. The joint permits relative rotation of the ends and accommodates the variations in track which accompany suspension movements.

The problem of rear wheel adhesion with a racing car of very high power : weight ratio has been approached in the Formula II Lotus by keeping the unsprung weight of the de Dion axle assembly to a minimum. To this end, the disc brakes are mounted inboard of the drive shafts and the gearbox is combined with the final drive—following recognised practice for Grand Prix cars—in a single, chassis-mounted unit.

Longitudinal location of the axle is governed by a parallelogram linkage of three tubular radius arms, one at each end at axle level, and the third above the axle at its centre. The right-hand arm is triangulated, and is provided with a second pivot on the same axis as the first, at the opposite side of the chassis frame, to provide lateral location. This arrangement is superior to the Panhard rod, which must of necessity allow some lateral axle movement and a rear steering tendency; it appears to be lighter than a central roller and guide plates. Magnesium alloy castings, bolted to the flanged ends of the axle tube, house the hub bearings and



A Watts linkage, together with a swinging half shaft, which does not incorporate a sliding joint, locate each rear wheel of the Rover gas turbine car. Variations in track are accommodated by a single sliding joint in the de Dion tube. The flexible gaiter that encloses the joint can be seen clearly



Three radius rods locate the de Dion tube of the rear suspension of the Lotus Formula II car. As can be seen in this illustration, one of these rods is formed by a triangulated tubular fabrication and another, which is a single tube, is pivoted above the combined gearbox and final drive unit

respect of rear wheel adhesion during traction or braking on poor or slippery road surfaces, a condition worsened by the preponderance of weight carried by the front wheels.

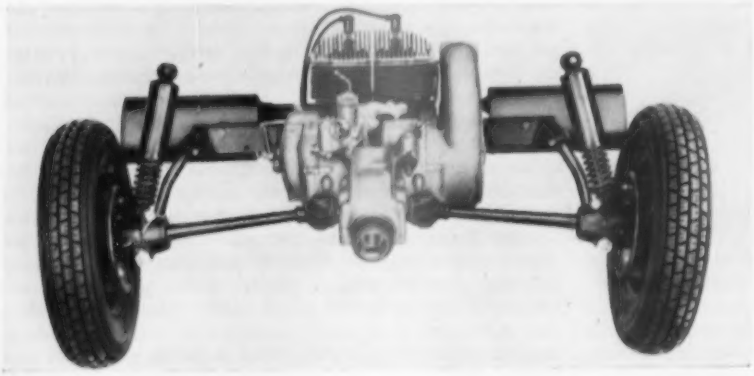
Road conditions on the Continent, and the marketing by a number of large manufacturers of rear-engined models, have encouraged the development of independent rear suspension designs. The associated vice of an excessive oversteering tendency is being largely overcome, so that the combination of acceptable handling characteristics and superior wheel adhesion constitutes a threat to British car exports in territories where poor roads prevail.

In the Renault Dauphine introduced this year, the pure swing axle layout similar to that of the smaller 750 model has been adopted. In the simplicity of this design there is evidence that production cost is comparable with that of a conventional axle. Other manufacturers using swing axle designs incorporate suspension arms whose function is to modify the swing axle effect, with the object of increasing the radius of the arc through which the wheel moves.

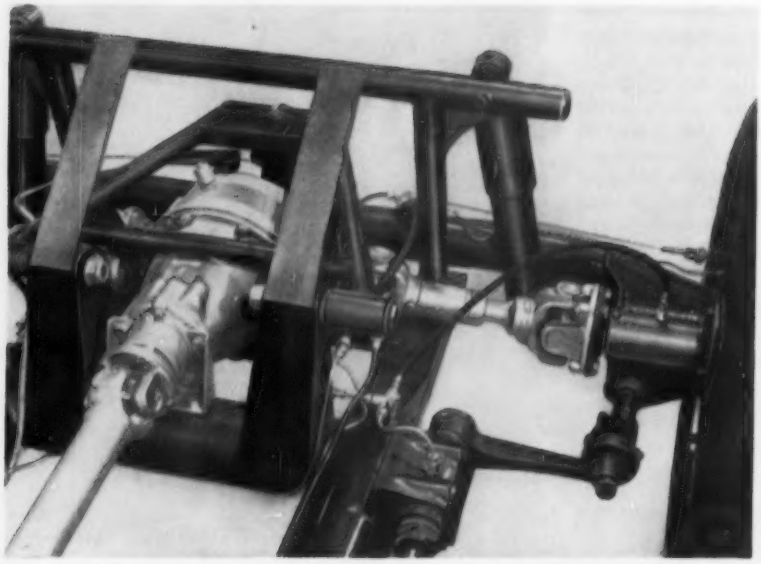
Another device is to lower the point about which the wheel moves, as pioneered by Mercedes-Benz and adopted this year by Porsche for their R.S. Spyder competition model, which was exhibited. Both manufacturers use a common central pivot, below the wheel centres, for the arms, but the Renault turbine car displays a similar arrangement with two pivots separated by a short distance. The object of all

outer universal joints. The bolt-on wheels are cast in magnesium alloy and have a web thickness of ¼in. They have a negative camber of 3 deg to increase the lateral adhesion of the outer wheel when cornering.

Disinclination to supersede the live axle in rear suspension design persists among British and American manufacturers. It is to be expected that conventional layouts should continue to suffice for the large and heavy transatlantic product, but at home alternatives must surely be sought soon. Many small and medium size cars leave much to be desired in



Combined coil spring and telescopic damper units, in conjunction with trailing arms and swing axles, are used on the Goggomobil



On the Frazer-Nash Continental, braking and driving thrust are transmitted to the frame by the torsion bar levers. Transverse location is effected by an A-bracket connected by a ball joint to a pillar welded above the centre of the de Dion tube

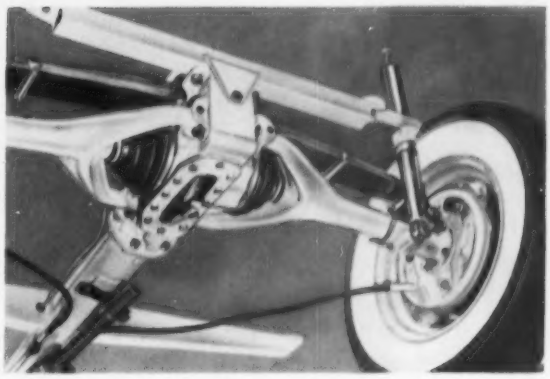
Welded pressings form the swing axles of the rear suspension of the Skoda chassis, which has a tubular backbone frame

these variations is to reduce slip angle at the tyre when cornering, and in the low pivot point design the height of the rear axle roll centre is reduced.

On the diminutive Goggomobil there is a swing axle of the utmost simplicity, as befits a model with a very low market price. The open half-shafts have universal joints at their inner ends, and share with a single radius arm at each side the function of wheel location. Hence the universal joints act also as suspension pivots. From observation of the large camber angle of the wheels when the car is unladen, it is clear that there is difficulty in keeping camber variations within reasonable limits when the swing axle radius is small and passenger loads constitute a considerable proportion of the all-up weight of the car.

Where there is a choice of independent or de Dion layouts as in a front engine, rear-drive chassis, there remains the tendency to use the non-independent design. Although more costly to manufacture and usually having a higher unsprung weight, it presents fewer problems, especially for high performance cars. Lancia, in their latest Flaminia model, exhibited for the first time at Earls Court, use a de Dion tube in conjunction with semi-elliptic leaf springs and a Panhard rod—a strongly traditional approach.

Frazer-Nash employ the same means of locating the de Dion beam of their new Continental model as they use in their live axle layout. Longitudinal torsion bars have horizontal levers, attached to swinging drop links on the axle tube by means of ball joint assemblies. A triangulated tubular member, pivoting on a horizontal axis parallel with the axle centre line, is connected to the centre of the de Dion tube by a ball joint. It serves to locate the axle laterally and, together with the suspension links, transmits braking torque and driving and braking thrust to the chassis frame. Koni telescopic dampers—a high quality unit manufactured in Holland—are fitted.



BRAKES

Few Changes in Conventional Equipment; Further Progress in Disc Brake Development and Production

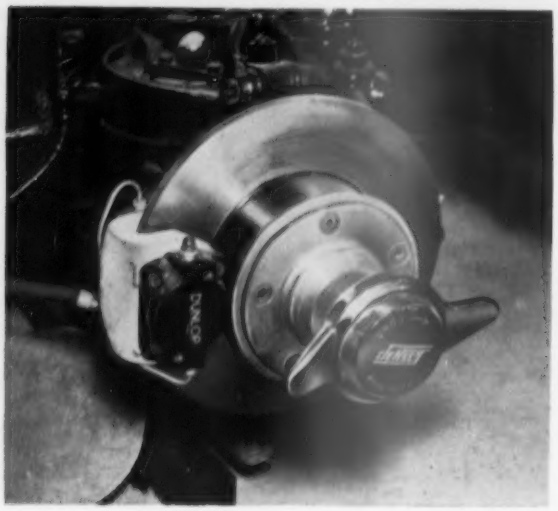
BRAKING equipment of the majority of British and foreign makes of car seen at Earls Court differs in no important respects from that current a year ago. Among factors which have restricted the possibilities of further improving braking efficiency in this country, not the least important are the economic conditions which have prevailed during the last twelve months, increasing production costs, and the necessity to maintain prices at competitive levels. Practical difficulties still persist, particularly in the dimensional sense imposed by chassis designs, and shortcomings in brake performance continue to be attributable in part at least to the shrouding effects of modern bodywork.

These factors must be taken into account when considering whether the best solution of the braking problem lies in the wide adoption of the disc brake. On this point opinions appear to be divided, though the Earls Court exhibition provided further evidence in favour of the disc, by drawing attention to the considerable progress recently made not only in design but also towards quantity production. Revised designs have been introduced, and were exhibited, by all the

proprietary disc brake manufacturers, and examples were installed on a greater number of vehicles in the show than was the case last year.

The new Dunlop brakes were seen on the Austin-Healey record-breaking car. They are standard equipment on the Jaguar D-type and Jensen 541 cars, the latter being the first British saloon to be so equipped. The latest version of the Girling brake was shown as a standard front wheel feature of the Triumph TR3, and was again seen on the front and rear wheels of the Lotus Eleven Le Mans sports car and the new Formula II racing car of the same make. On the two latter vehicles the rear brakes are inboard-mounted. Hydraulically-actuated, inboard front and rear disc brakes have also been selected for the experimental Renault Shooting Star and Rover T.3 gas turbine-driven cars—Dunlop for the former and Girling for the latter. The front-wheel-drive Citroen DS19, seen at Earls Court last year for the first time,

Dunlop front wheel disc brake on the Jensen 541 car



continues to have the makers' inboard-mounted front wheel disc brakes and distributor valves, whereby the braking force applied to the front and rear brakes is adjusted automatically according to the loads carried on the axles.

These exhibits may well have created the impression in some minds that a general change-over to disc braking for private cars had begun in earnest. Whether such a development is imminent or will be delayed by conditions in the industry, it seems probable that at first it will be confined mainly to the front wheels of high-performance cars, and much will depend upon the experiences of private owners of the disc-braked examples recently put into production.

At the exhibition there was an unusual scarcity of new designs of brake application equipment. It was to be noted, however, that two manufacturers have taken advantage already of the legal permission to transfer the hand brake from the rear wheels to the transmission. A point in favour of this location is that it reduces unsprung weight, though it calls for some provision to facilitate periodical servicing attention.

In its latest form the Dunlop disc brake is the result of 10 years' research and experience, including that obtained with aircraft braking and with Jaguar, Austin-Healey, Maserati and Connaught racing cars during the last five years. The Dunlop Rim and Wheel Co., Ltd., announce that they have now installed in their Coventry factory plant

On the Jensen 541 saloon car, the disc brakes on the rear wheels are hydraulically- and mechanically-actuated Dunlop units. Mechanical actuation, of course, is for hand application

for disc brake manufacture on a large scale for production cars. A number of examples suitable for cars of different types were displayed on their stand, including a complete installation with hydraulic application equipment, similar to that of the Jensen 541.

Unlike racing car installations, which have three and two friction pads on each side of the disc for front and rear brakes respectively, the brakes for normal road usage have only one pad on each side. For both front and rear brakes a ferrous caliper is mounted on the back plate. Circular pads, 2¼in diameter and ⅜in thick, are secured to carrier plates. They are applied to the disc by pistons, each of which is contained in a cylinder attached by four set screws to each side of the caliper and not integral with it, thereby providing a degree of insulation from brake heat for the pistons. A further advantage of this feature of design is that it permits the fitting of cylinders of different sizes to meet particular

The new Girling hydraulic disc brake incorporated in the front wheel assembly of the Lotus Eleven, Formula II racing car

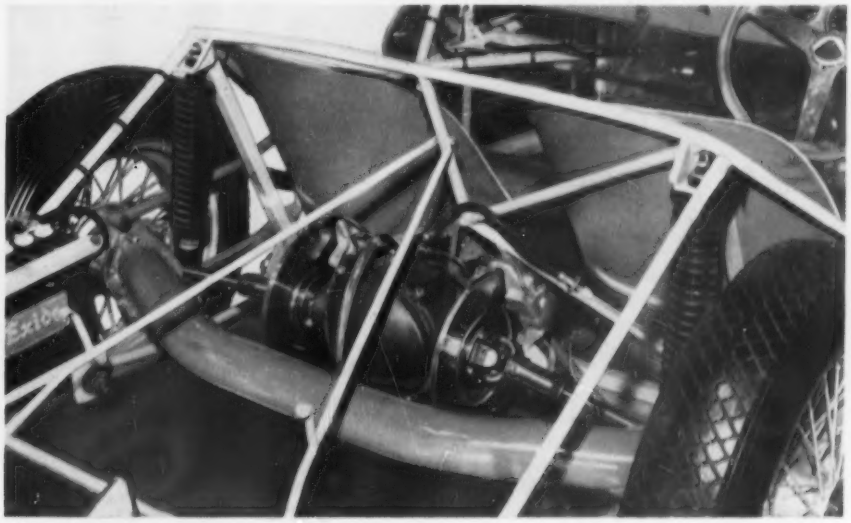
requirements. Piston pressure is applied through central, ball-ended plugs which present small areas of contact, with consequent heat-insulating effect, and which by universal movement distribute the pressure and wear equally over the working faces of the pads. The pistons are fitted with rubber seals to exclude water and dust.

A simple retraction device ensures a small, constant clearance between the pads and disc when the brakes are off. Each pad carrier plate is formed with two lugs at diametrically opposite points. Through countersunk holes in these are inserted headed retractor pins, which are passed through two coil springs and are a fairly tight fit in two bushes. The bushes and the springs are contained in the cylinder casting, and are allowed 0·010in free sliding movement. When the brake is applied, the bushes are pulled by the retractor pins, compressing the springs. Upon release of the hydraulic pressure the springs move the bushes back 0·010in, so that the carriers are drawn back to give that amount of pad clearance. As the pads become worn the retractor pins are gradually drawn through the bushes by application of the brakes, maintaining a constant clearance throughout the wearing life of the pads. Stops prevent further movement of the carriers when the pads are in need of replacement. The ends of the retractor pins project through the cylinder casting and the state of pad wear can be ascertained by measuring the pin protrusion.

For parking and emergency application, the hand brake pads are secured to carriers pivoted to the hydraulic brake caliper on either side of the disc. They are applied to the disc with equal pressure by contracting mechanism operated by cable. Adjustment by nut is provided, and a spring ensures clearance when the brake is released.

The brakes fitted to racing cars, such as the D-type Jaguar for example, have rectangular friction pads held in place by a retaining plate secured by a pin. For quick replacement the pad carriers are provided with lugs, by which they can be easily extracted through apertures in the caliper, after withdrawing the pin to release the retaining plate. The lugs and plate are slotted to permit inward movement of the carriers as the pads wear.

Operating on the Hydrastatic principle, which affords automatic adjustment, the latest Girling disc brake is of particularly simple design. The caliper is a one-piece, ferrous casting, incorporating the hydraulic application cylinders, which are connected by a pressure-balancing bridge tube. The friction pads are of segmental shape, an advantage of which is that the braking effort is distributed uniformly across the working faces of the disc. The pads are bonded to steel carrier plates, and a feature of the design is the extreme ease with which they can be removed for replacement through a central aperture in the caliper, without disturbing the hydraulic pipe connections. They are retained by small, triangular plates, which are secured by set screws at the top and bottom of the aperture. It is necessary only to loosen the screws and swing away the plates to withdraw the pads. The state of wear of the pads can also be seen at a glance through the aperture.



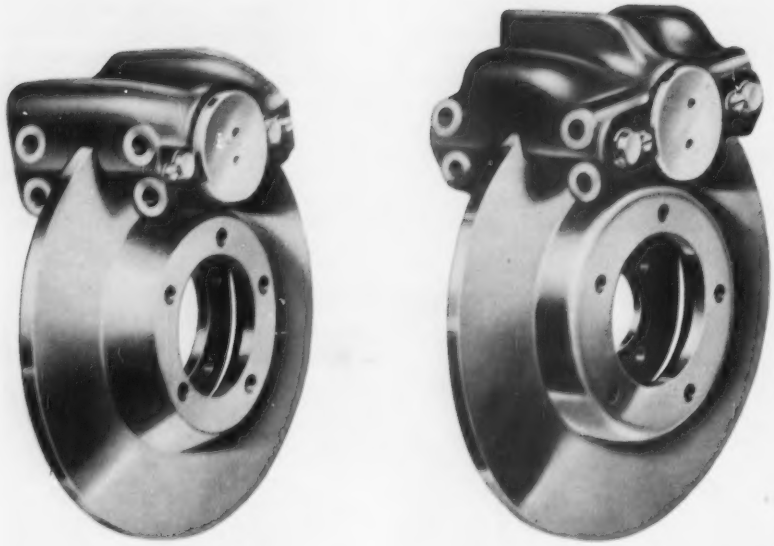
Cooling problems often can be solved readily by mounting the brakes on the final drive unit, as are these Girling disc brakes on the Lotus Eleven Le Mans car

The front and rear brakes are of similar design, though the caliper of the latter also supports the mechanically-operated hand brake mechanism, by which additional friction pads are applied to the disc. The hand brake pads are carried on caliper members which are pivoted to the hydraulic caliper casting on either side of the disc. At the lower end of one member is pivoted the operating lever; a cable attached to its upper end has an adjustable rod connection to the other member just above the pivot point. Actuation of the operating lever thus applies the pads to the disc with equal pressure, against the action of a spring which normally maintains a slight clearance. A similar assembly has also been introduced for a hand-operated transmission brake.

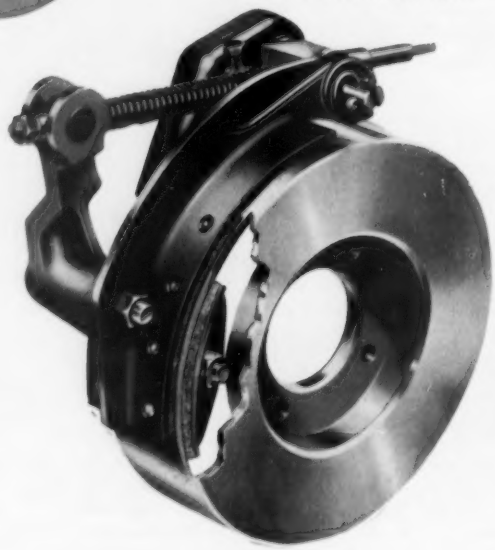
The two new disc brakes introduced by the Lockheed Hydraulic Brake Co., Ltd., are intended for the front and rear wheels of high-performance cars weighing 30 cwt or more. The rear wheel brake assembly is also suitable for the front wheels of cars weighing under 30 cwt. They are of similar design, though larger hydraulic cylinders and a more robust cast iron caliper are used for the front wheel brake.

In each case the caliper is bored to accommodate the cylinders, which are closed by end covers screwed into position against sealing washers. Segmental friction pads are bonded to carrier plates and are located by two pins, which are passed through the caliper casting and fit in grooves at the top and bottom of the carrier plates and friction material. To gain access to the pads for replacement or examination, it is necessary only to remove two set screws securing the caliper to the back plate and those holding the retaining plates of either the top or bottom pair of pad

Production versions of the latest front and rear wheel disc brakes of Lockheed design



This drum type transmission brake exhibited by Lockheed is sectioned to show the inner and outer friction pads



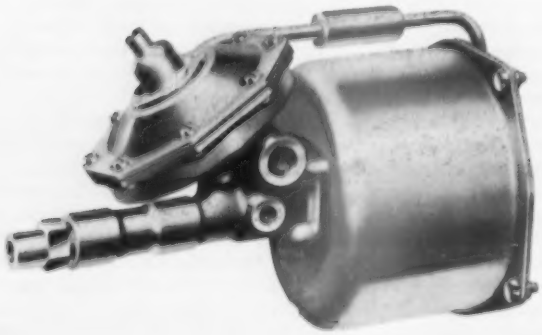
locating pins. When the pins are withdrawn, the caliper can be swung away from the disc and the pads extracted without disturbing the flexible hydraulic hose.

A new feature of the Lockheed design is the automatic adjusters inside the hollow pistons. In each piston, two slippers are held in contact with the piston inner wall by a strong diametral coil spring. The slippers normally follow the movements of the piston and work in slots in a fixed pressing. The length of the slots corresponds with the normal braking movement, and determines the length of the piston return stroke after brake application. When the wear of the pads exceeds a certain amount, the slippers are forced to move backwards inside the piston so that the latter, on release of the brake, does not quite return to its previous position.

Another new Lockheed production is a hand-operated drum transmission brake designed to afford the advantages of a large diameter disc brake without radial distortion or expansion, which may be experienced with brake drums of the conventional type. Though it provides a large braking area, the diameter of the drum is only 8in, so that the brake can be accommodated where underfloor clearance would not permit the use of a disc unit of similar braking capacity.

This device operates by applying friction pads with equal pressure to the inner and outer surfaces of the drum, both of which are machined. The outer pad carrier or shoe is formed with a central flange, by which one end is pivoted to a fixed anchorage carried by the mounting bracket and fitted with a pull-off spring. Near the other end is pivoted an operating caliper member, to the outer end of which is attached a Bowden cable by which the brake is applied. The inner end of the caliper is turned to enter the drum, and on it is pivoted the inner pad carrier. Thus the drum is pinched between the two pads when the brake is operated by the cable. A nut adjustment is provided for the cable attachment, and the action of the return spring normally maintains a slight clearance.

The new Lockheed 5½in, vacuum-actuated, brake booster



On the Lockheed stand were exhibited for the first time two new vacuum brake booster units. Intended for the faster, heavier cars, these are of the suspended vacuum type and are similar in design, though they have servo cylinders of different sizes—one 5½in and the other 6½in diameter. In operating principle they are the same as the well-known Lockheed Hydovac unit, and, in the same way, have the piston of the hydraulic slave cylinder connected directly to the piston rod of the vacuum servo cylinder. In the normal position, with the brakes off, vacuum is maintained on both sides of the servo piston. To apply servo assistance, air is admitted on one side of the servo piston in proportion to

the actual working stroke, instead of exhausting air from the whole cylinder as in the conventional vacuum Servo. Thus the fitting of a vacuum reservoir is not absolutely necessary, though its inclusion is generally advisable.

A special feature of the new Lockheed units is the compound vacuum control valve, which ensures early vacuum assistance with light pedal pressures. It consists of a diaphragm, divided into two concentric portions by a circular metal pressing riveted to the diaphragm material, and held against the casing by a spring. The diaphragm and associated valves are operated by hydraulic pressure created by the master cylinder, which in the initial stages has to overcome only the pressure of the centre portion of the diaphragm in order to open the valve which admits air to the servo cylinder. When the pressure rises to a certain figure, the circular pressing is lifted off its seat against the spring pressure and the whole diaphragm comes into action, giving increased resistance and preventing too much servo power being brought into operation.

The Lockheed booster is very simple to install and can be located in any position in the chassis. Since no provision has to be made against reaction, the unit can be mounted on light brackets. All the working parts are enclosed within the unit, though it is advisable to fit an air cleaner.

The new Lockheed 6¾in. suspended vacuum type, brake booster

Electrical Equipment and Heaters

Accessory Load Continues to Increase

TRENDS in electrical equipment reported a year ago have increased rapidly in momentum. The demands of road safety and driver and passenger comfort have stressed the need for additional lamps and accessories of all kinds and they were shown in wide and interesting variety at Earls Court. These, together with the greater use of electrically-operated chassis and body units, have led to continued improvement of controls and instrumentation, to simpler wiring systems and to a greater adoption of high capacity dynamos and current-voltage regulation to enable the battery to cope with the increasing loads.

In addition to the rapidly increasing popularity of the Borg-Warner and Laycock de Normanville overdrive units, and of the Manumatic semi-automatic transmission system—all electrically-controlled—three new transmission systems of great promise, one by Newton and Bennett Ltd., the others by S. Smith and Sons (England) Ltd., have made their debut. Arising from all these developments one fact stands clear—the motor vehicle electrician, both in factory and garage, must undertake a task of ever-increasing importance.

Dynamos and control boxes

Although there has been a considerable increase in the adoption of current-voltage regulation, the earlier compensated voltage-control system continues to be fitted to the majority of British and Continental cars. This is because it is quite adequate to the needs of cars of the low to medium price bracket. In this range the electrical load is comparatively small and well accommodated by a ventilated dynamo of reasonable output—that is, 19 to 22 amp, as in Lucas practice. In American cars, the compensated voltage-control system, known in the United States as the combined current-voltage system, finds little application. Because of the multiplicity of electrically-operated accessories and units fitted in American cars, current-voltage regulation, which they call the two-, three-, or four-unit system according to type, is employed. It is, therefore, all the more interesting to find that replacement control boxes for American cars are offered by Bosch, and that the voltage regulator of these replacement units is of the double-contact type.

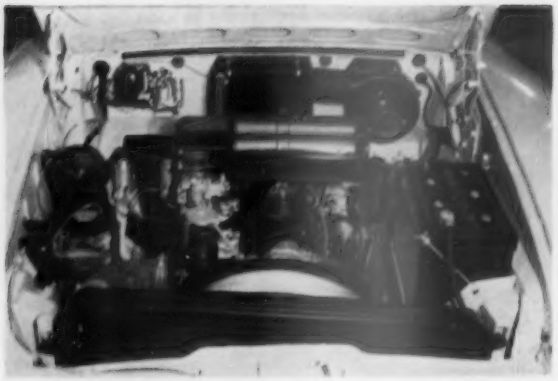
The advent of baby cars such as the new British Berkeley, the German Goggomobil and the British Unicar which was announced shortly after the Show has restored the dynamotor to favour. The unit used, called the Dynastork or Dynastorten on the Continent, is manufactured by Siba Electrik, G.m.b.H. One such unit is claimed to be the only combined starter and generator for internal combustion engines up to 700 cm^3 capacity. It is a 12-volt unit, and usually is coupled directly to the crankshaft.

Except for the well-known Wico-Pacy flywheel ignition type generators for caravan or motor boat lighting and battery charging, no alternators were exhibited. It was gratifying to note that on most foreign cars, American and Continental, British 12-volt practice has been adopted. Among the few exceptions were the Citroens, Porsches, Renaults and Volkswagens.

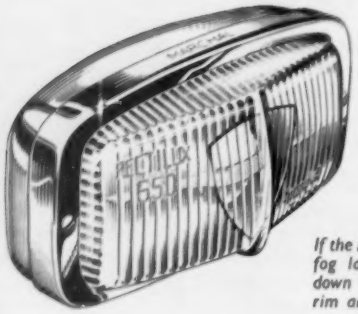
Batteries and lamps

As last year, the exhibits were all of well-tried products. Among the batteries were specimens of the Dagenite range with their special negative plates for good winter starting; the Ediswan low-priced Crown and Standard and high quality Extra-Life ranges; the Silver Exide with Porvic plastics separators, CB.95 alloy plate grids and hard rubber containers; King of the Road Lucas battery with its porous rubber separators, special grid alloy and toughened Milam case; and the Oldham Major with its Power-Seal plates.

In the Young range were specimens of the new Golden Crompton, Standard and Double-Duty batteries, all with factory-sealed charge which, it is claimed, gives a dry-charged shelf-life of 5 to 10 years. When these batteries are required for use, all that is necessary is to break the seal, fill with electrolyte and allow to stand for 30 minutes. It should be noted, however, that a 10-minute fast charge, controlled to a temperature of 110 deg F, is recommended. Oldham,



A noteworthy feature of the Standard Vanguard III is ease of access to the electrical units, all of which are supplied by Lucas



If the Marchal Rectilux 650/300 fog lamp is mounted upside-down below the bumper, the rim and light unit have to be reversed

The Lucas red stop-light indicator does not operate if one of the bulbs or circuits serving the bulbs is defective

and Buckland, too, produce batteries which are similarly dry-charged.

Access to the battery has been improved greatly on British cars. Two outstanding examples in this respect are the new 1¼ litre Singer Gazelle and the Standard Vanguard Mk. III. In both cases, the battery is located under the bonnet in accordance with the usual practice, but close to the nearside and front of the car where it is easily reached for servicing.

Some new head and fog lamps have been added to the Brenner range and, following the success of the Marchal Senior Fantastic models introduced last year, there are now Junior Fantastics for small- and medium-sized cars. Another interesting Marchal product is the Rectilux 650/300 fog lamp. It casts a widespread, flat-topped, yellow beam and is so designed that it may, if desired, be mounted upside down below the bumper merely by reversing the rim and light units.

A new fog lamp, called the Rotaflare and available from Harold Radford and Co. Ltd., Melton Court, South Kensington, London, S.W.7, has a remotely-controlled swivelling reflector and bulb unit, which turns inside the fixed lamp housing. It is operated by an armoured control cable from the dashboard, and pin-points objects on the road within an arc of 90 deg.

Also of interest was the Butlers Mark II version of the popular Saucer lamp range which, introduced last year, has recently reached full production. The design embraces several departures from conventional practice, among them being the facility with which the pre-focused bulb may be changed in the event of failure, without the need to dismantle the lamp front. By unscrewing the cap located in the centre of the lens, the flanged bulb can be withdrawn to the front. The centre cap screws on to a moulded rubber ring, which, in turn, seats on a machined face, thereby ensuring a watertight seal.

There were, of course, the high quality ranges of Bosch, Lucas and Notek lamps, and also the Lucas headlamp conversion sets whereby older cars can be esily modernised. Each set consists of interchangeable chromium plated rims, light units and block-pattern lens, pre-focus bulbs, adaptors and cable. The conversion lamps are easily secured in the old lamp bodies and their fitting involves only simple changes of existing wiring.

Lamp locations remain much the same as hitherto, the Americans following largely the practice of built-in and combined grouping of head and side lamps, the British—except for some Fords which have adopted American practice—preferring built-in but independent units. In this respect, Continental cars follow the British fashion.

Most, if not all the American headlamps are well hooded. This practice, in a more conservative form, is being adopted increasingly by British manufacturers as, for example, in the new Ford Zodiac convertible, with its hooded extensions from the wings, and the Morris Oxford Series III with extended lamp rims. Apart from the lighting efficiency gained from this arrangement, the appearance of the car is enhanced. Also worthy of note is the advent of the Desmo Beamdicator—a combined headlamp beam shield and width indicator.

One answer to the dipping problem appears to have been reached in the American Lincoln Premiere, although at the cost of some complication, apparently. An automatic headlight control, working, possibly, upon the photo-electric cell principle, dips the beam when another car approaches, and raises it when the car has passed.

A new Lucas development in rear lighting is the Model No. 4RA stop-light indicator, which gives a positive indication that both stop lamp filaments are actually alight. It takes the form of a red indicator lamp, arranged for easy mounting on the facia; it lights only when both bulbs are taking their rated current. The eye rapidly becomes accustomed to associating the lighting of the indicator lamp with depression of the brake pedal; failure of the indicator to light thus gives immediate warning of failure of one or both stop lamp filaments.

Contact to the indicator bulb is made through a bi-metal strip. The heating effect of the full stop lamp current, 3½ amp, flowing through the bi-metal causes the latter to bend sufficiently to complete the bulb circuit. Any lesser current value does not give rise to the temperature increase necessary for full bi-metal flexion.

The general trend is to incorporate the now obligatory red rear reflectors in the rear lamps. Two such Lucas lamps for replacement or modernisation purposes are the Models 549 and 551. Both are designed for fitting in matched pairs, as the law requires, and incorporate a 21/6 watt non-reversible bulb enclosed by red lensed covers moulded in the thermoplastic Diakon. A new range of three-bulb rear lamps with built-in reflectors has also been introduced by Wico-Pacy, and Tudor Accessories, Ltd. have brought out a highly efficient reflector tape called Flexlite.

Most novel incorporation of rear lighting was that seen on the Buick Centurion experimental car. The stop and reversing lights are located in a "bomb" in the middle of the back of the car. When the lights are not in use, the bomb appears to be of metal, owing to the reflecting nature of the outer lens. The tail lights are similarly designed.

Direction indicators and horns

There has been a considerable increase in the use of flashing type direction indicators, but the semaphore type is still popular. It was, therefore, not surprising that in addition to flasher sets, Lucas exhibited the latest SF80 flush fitting and SE100 external mounting, moving arm indicators.

Two-lamp flasher sets, complete with bulbs, flasher unit, steering column selector switch, warning light, outlet wiring and self-tapping screws, have been added to Wingard range of products. The lamps are particularly suitable for fitting to the sides of the car. Also on view were the well-known two-lamp Marchal sets.

To the Butler range of lamps have been added amber direction indicator lamps to match the popular 1323 range of combined stop and tail lamps. The amber version can be had in standard or de luxe form, the latter incorporating a chromium-plated bezel. This embellishment is also offered separately for those who wish to add it to existing stop-tail lamps of the 1323 type.

A new form of direction indicator lamp was to be seen at the front of the Lincoln Premiere. It consists of a strip light which shares a long rectangular housing, divided at the centre and located immediately above the bumper. In the other half of each housing is a parking light. Being in the form of a strip, either light, when in operation, gives and indication of the outline of the car. At the rear the strip lights are used only for reversing, the stop, tail and direction indicator lights being housed in rearwardly-canted housings, framed in the upper part of the wings. These housings, triangular in shape, are sufficiently large to occupy the complete upper portion of the wing extremities. Another American innovation was to be seen on Packard models. When the headlights or the parking lights are switched on, an external courtesy light, throwing its beam upon chromium-plated strip embellishments, outlines the side of the car as the door is opened.

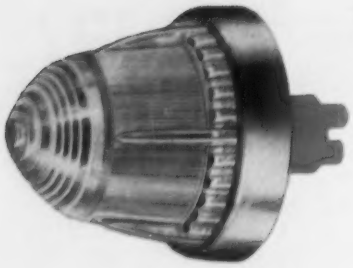
Horns were more or less unchanged, the usual ranges of Bosch, Lucas and Marchal being well in evidence. There appears to be a tendency, however, to fit them in matched pairs. This is particularly the case with the well-established high-note and low-note Lucas WT 614 wind-tone horn, which has been redesigned and is now known as the model WT 618. Although the current-drain of this new horn is very little more than that of its predecessor, the note produced is louder, sharper and clearer. The Marchal Musical, the horn that plays a tune, is still favoured by many Continental manufacturers.

Windscreen wipers and washers

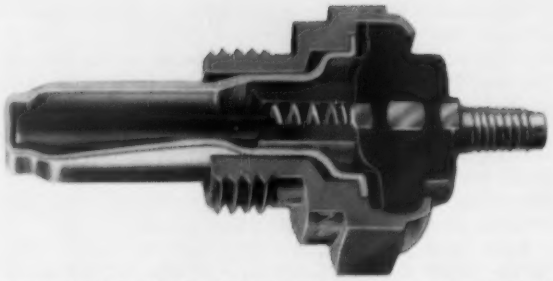
Two-speed, self-parking, twin-blade windscreen wipers proved to be the rule rather than the exception on British and Continental cars, whereas most American cars continued to favour the variable-speed, self-parking, twin-blade type. It should be noted, however, that the AC-Delco electric screen wiper—a two-speed self-parking unit described in the November 1956 issue of *Automobile Engineer*—has already been adapted for some American cars. This unit is standard equipment on Vauxhall cars. On most other British models, the Lucas DR2 unit is fitted. The Bosch windscreen wiper is popular on Continental cars and, incidentally, is now offered to the British market.

Among windscreen washers, the Lucas Screenjet, introduced last year and now available in either 6- or 12-volt form, has become standard equipment on a number of British cars. Wired in conjunction with the wiper so as to set both the wiper and washer in action simultaneously, it makes a useful contribution to driving convenience and to

Front and rear end lighting of the Lincoln Premiere. Left: The strip type parking and direction indicator lamps are in a wide rectangular housing above the bumper. Right: The triangular lamp houses the stop and tail lights. A strip type reversing lamp is employed



The Butler amber direction indicator lamp



Sectioned exhibit showing the heat-sensitive resistance element of the AC temperature gauge actuating unit

AC Vivid Arc speedometer: above, as seen when the car is stationary and below, when the car is running. The illuminated arc moves round the dial as the car speed increases. This instrument also incorporates fuel and temperature gauges, and warning lamps for ignition, oil pressure, headlamp beams and direction indicators

safety. Joint operation of washer and wiper has also been incorporated in Trico units. The Trico wiper is of the pneumatic type and, by means of a special valve system called the Trico Washer Co-Ordinator, both units are brought into action when a single control button is depressed.

Ignition and accessories

Other than a further development of the K.L.G. high-performance, platinum-pointed sparking plug, there were not many novelties in the field of ignition. K.L.G. have added silver to the platinum of the electrode. This, with its higher heat conductivity, helps to reduce the working temperature of the tip. Its resistance to chemical corrosion is another advantage.

Champion and Lodge showed plugs with improved electrodes, the former claiming that their new electrode alloy has a much lower corrosion and gap increase rate than that formerly used. Lodge introduced "Chromised" electrodes, in which chromium is absorbed into the electrode material by a special process quite distinct from the conventional electro-plating. The aim is at ensuring a much longer trouble-free plug life without the need for frequent inspection and adjustment.

Two features in ignition circuits were worthy of note. The first was the adoption of the combined ignition-starter switch on a large number of British and Continental cars. The second was the use of two ignition coils on the German Goggomobil, with a parallel-twin two-stroke engine, to dispense with the distributor.

Among accessories which make for road safety, two new units were to be seen; one is British, the other American. The British item, a K-L exhibit called the Clearview, is a demister bar designed for use with the popular curved and wrap-round windscreens and rear windows. The bar is a slim, chromium-plated tube containing a black-heat element in a heat-transferring electrical insulator. Suction cups at each end of the bar make attachment simple. The bar can be bent easily to conform with the contours of the glass, so ensuring maximum efficiency over its 15½in length. It is available in all voltages.

The American unit, seen on the Buick Centurion consists of a television camera and viewer screen to keep the driver informed of vehicles approaching from the rear. It is a complex and undoubtedly expensive device involving a special closed-circuit television camera enclosed in the boot, transmitting its image to a special 4in × 6in television receiving tube installed in the instrument cluster. The driver sees a conventional mirror-like but green-tinted image, and two control knobs at the viewing tube control brightness and contrast. On a dull day the device enables the driver to see further with less eyestrain than with the conventional mirror and it is claimed that it eliminates dazzle from cars approaching from the rear at night. Of miscellaneous electrical accessories there has been a considerable increase. These range from courtesy, map and inspection lights, cigar lighters and so forth to dry shavers, Grundig Stenorette tape recorders, and refrigeration units on Bentleys and Rolls-Royces.

Controls and instruments

Improvements in the grouping of controls and instruments continue, and British manufacturers are well ahead in this respect. Two of the best examples on small and medium-size cars are the Hillman Minx and the Wolseley Fifteen-Fifty respectively.

There has also been improvement in the legibility of dials on some facias; a typical example is to be found on the Jaguar Mark VIII. Here the graduations and pointers show in a brilliant heliotrope in daylight, and at night their black-lighting prevents the driver's attention from being distracted. British Jaeger instruments of this kind are fitted to many British cars.

From the comprehensive Smiths range, electric temperature gauges and electric clocks are finding increasing applica-

tions. On the Auston A90 Westminster, a Smiths 2in rectangular electric clock with frontal reset and regulator controls is fitted as standard equipment, and for the Austin A40 and A50 Cambridge, it is offered as an optional extra.

The AC Vivid Arc speedometer, described in the November, 1956 issue of *Automobile Engineer*, is standardized on Vauxhall cars. It employs an illuminated, orange-coloured arc to replace the conventional pointer, and it gives a progressive colour build-up from zero to indicate speed; 240 deg of the dial is used for speed recording. The visual effect is excellent both in daylight and at night. It is claimed that the new arrangement keeps the driver aware of his speed without the need for definite glances away from the road to read the instruments. The colour was chosen to help motorists who may suffer from colour blindness. Included in the instrument are temperature and fuel gauges, winking direction indicator warning lights and normal ignition, main beam and oil pressure warning lights.

The AC electric temperature gauge is a further step towards the complete electrification of the instrument panel. It utilises a heat-sensitive engine unit with a negative temperature coefficient. As the temperature increases, the resistance of the engine unit decreases, modifying the current passed to the dash unit, which is calibrated in terms of temperature. The unit is fully compensated against variations in the voltage of the electrical system.

As usual, the feminine aspect is well catered for on American cars. Facia panels are becoming less ostentatious and more elegant. There are still, however, push-button controls for almost everything. On the Packard Patrician a new form and application of push-button control for the Ultramatic transmission system is called Electronic Push-Button Control. The push buttons, N, L, H, P, R, D are grouped at the extremity of a steering wheel spoke—this is a neat and convenient arrangement.

Chassis and body units

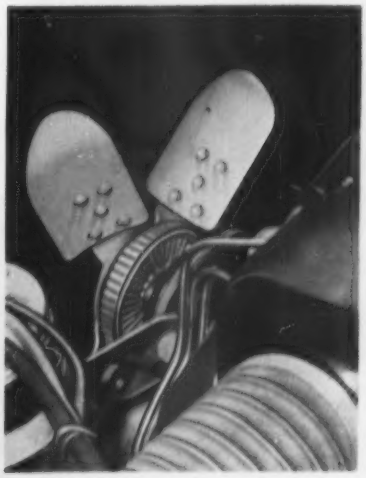
Two units used with the engine are of particular interest, one is American, and the other British. The American device switches in and out the fan on the Mercury Montclair. It is claimed to save 17 h.p. which is normally wasted. When the fan is not needed for cooling—which in normal driving is said to be 80 per cent of the time—it is disengaged by an electro-magnetic clutch, which is actuated by a thermostat. An indicator on the facia panel records the operation of the device.

The British unit is the K-L Gulf-Stream engine pre-heater. It is a miniature electric immersion heater which can be fitted in the radiator hose. Plugged-in to the garage light socket, it maintains the engine temperature at working level during the coldest weather, so contributing to quick starting.

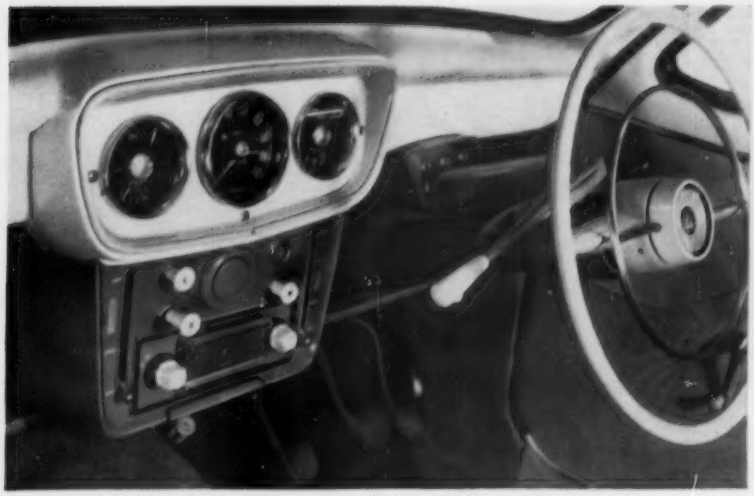
In transmissions there were, in addition to the Ferlec electromagnetic clutch on the Renault Dauphine saloon, electrical controls on the Manumatic clutch offered as an optional extra on a number of British cars; on the Standrive two-pedal system, on the fully automatic Laycock de Normanville overdrive with the latest Lucas model SB60 relay units and 48SA throttle switch, and on the Rover and Smiths automatic transmission systems. The mechanical arrangements of the Standrive, Rover and Smiths systems are reviewed in the report entitled "Transmission" which appears earlier in this issue.

Only two electrical units are required in the Standrive system—one a push-button switch in the knob of the gear leaver, the other an electromagnetically-operated pneumatic valve. The switch is in circuit with the solenoid of the valve, and the valve is arranged in a pipe-line. One end of the pipe goes to a vacuum tank, which is connected to the engine inlet manifold, and the other end is connected to the clutch withdrawal servo. When the gear lever is grasped in the usual manner, the switch is closed and the valve brought into action to operate the clutch. A similar arrangement is employed for clutch withdrawal in the Rover system, but there are additional Lucas units to control the fully automatic Laycock-de-Normanville overdrive.

Of these, the new model SB60 unit follows the same construction as its predecessor—the SB40—except for an additional pair of contacts, which when the relay coil is energised, connect the contacts to the supply. Quite different from its predecessor, the model RTS1, is the Lucas model 48SA throttle switch. It combines the functions of four electrically separate switches in one unit. Of these four switches (*a*) is closed from fully closed to half throttle, (*b*) from $\frac{1}{2}$ to full throttle, (*c*) from fully closed to $\frac{1}{16}$ throttle, and (*d*) always except during kick-down of the accelerator pedal beyond its normal travel. All the remaining Lucas



Above: On the Mercury Montclair, the fan assembly has an electromagnetic clutch



Left: The grouped arrangement of controls and instruments on the Hillman Minx

The Lucas 48SA throttle switch for fully automatic overdrive control. It differs, in both shape and construction, from the type employed for semi-automatic control

units of the control, the gearbox switch, the centrifugal switch and solenoid units, remain unchanged.

The road speed at which the contacts of the centrifugal switch close depends upon the characteristics of the car, and can be varied to suit each model. With the centrifugal switch closed, the change to overdrive gear takes place immediately the accelerator pedal is eased back to half throttle opening or less. When this occurs, the relay operating coil is energised via the throttle switch contacts (*a*) and (*b*) and the centrifugal switch-contacts, causing the relay-units to close, so connecting the battery supply to the solenoid unit. The multi-contact switch linked to the throttle has the effect of over-riding the centrifugal switch in certain throttle positions. In this way, the change to overdrive is delayed when the car is accelerating from rest, with large throttle openings, by throttle switch contacts (*a*) remaining open when the throttle is more than half open.

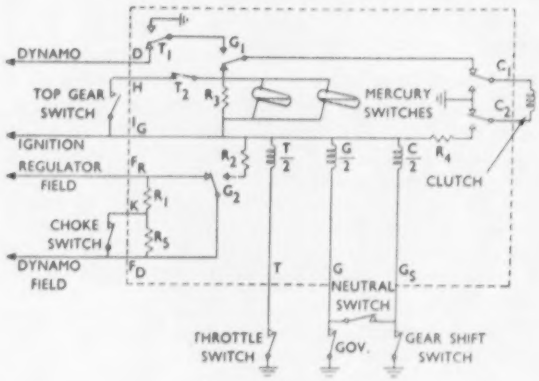
After the relay unit contacts close, overdrive is available over the whole range of throttle opening until the road speed falls to the predetermined level, at which the centrifugal switch contacts open. This, it will be noted from the diagram, is because when the relay contacts are closed, throttle switch contacts (*a*) and (*b*) are by-passed through contacts (*d*). To prevent hunting—too frequent changes into and out of overdrive—a differential of about 5 m.p.h. is provided between the opening and closing of the centrifugal switch contacts.

The kick-down device engages direct drive when required, even if the car is running above the cut-in speed of the centrifugal switch. It depends for its operation on the opening of a pair of throttle switch contacts beyond the normal full throttle pedal position. With the accelerator so depressed, throttle switch contacts (*a*) and (*d*) are opened, thereby cutting off the supply to the relay coil. Consequently, re-engagement of the overdrive does not occur until the accelerator has returned to half throttle opening or less. Conscious, positive intention is required to press the accelerator pedal past the fully open throttle position, and this ensures that unintentional changes to direct drive are not made when the driver wishes to accelerate in overdrive gear.

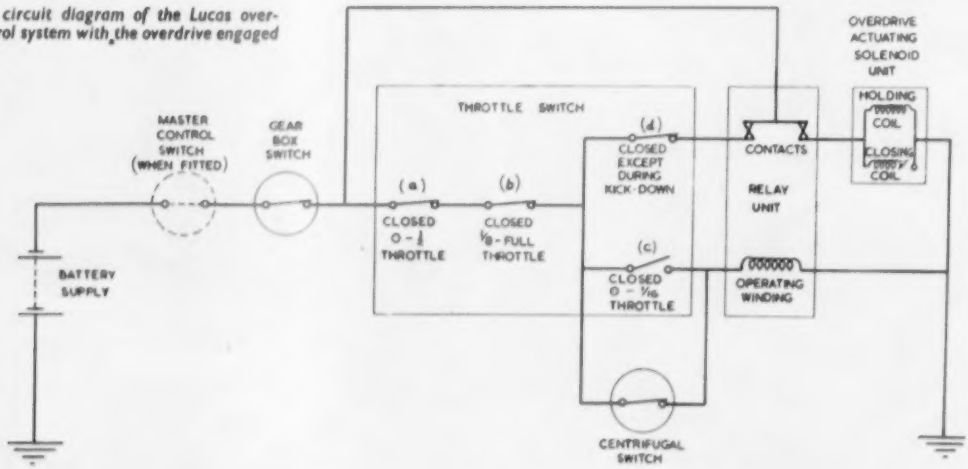
The primary function of the relay is to provide a direct path for the supply current passing through the gearbox switch to the overdrive actuating solenoid. The additional function is to produce a secondary path for the supply to the relay actuating coil, so ensuring that the overdrive does not disengage when the throttle is opened more than half way. Additionally it prevents disengagement when the throttle is fully closed and the centrifugal switch contacts are open. To engage direct drive the accelerator must be depressed slightly to open the throttle switch contacts (*c*) and accelerate the engine, so preventing an unpleasant jerk through the transmission.

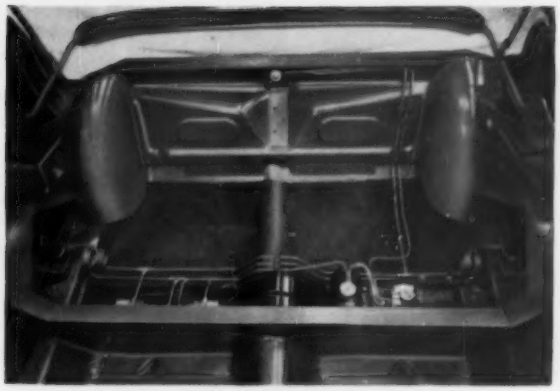
For effective engine braking on hills, the throttle switch contacts (*b*) retain the car in direct drive. The engine may accelerate owing to the gradient, and the centrifugal switch contacts close, but the open contacts (*b*) prevent the relay unit from operating. The overdrive control on the Rover 105R automatic transmission system is the same as that

Circuit diagram of the Smiths Selectroshift two-pedal control system. The C/2 relay has contacts C_1 and C_2, the G/2 relay has contacts G_1 and G_2, and the T/2 relay has contacts T_1 and T_2



Electrical circuit diagram of the Lucas overdrive control system with the overdrive engaged





This illustration shows the Smiths electro-hydraulic hood actuating equipment installed in a Ford convertible car

described, except that an additional centrifugal switch ensures that overdrive is in operation at or above 70 m.p.h., irrespective of the engagement of the kick-down switch.

The immediate application of the Smiths magnetic powder clutch has been in elimination of the clutch pedal, although gear-changing is still accomplished in the usual manner by moving the manual lever. This semi-automatic transmission system has been named the Selectroshift. Apart from the special clutch referred to, its prime requisite is a switch incorporated in the gear shift control in such a manner that the clutch excitation circuit is automatically broken when the gear shift lever is operated.

Smooth and progressive starting from rest, giving similar characteristics to those of a fluid coupling, is provided by using the rising voltage obtained from increasing dynamo speed to energise the clutch during take-off. For this purpose, the standard build-up characteristic of the dynamo is temporarily modified by a road speed governor and a relay system. The road speed governor is driven in tandem with the speedometer and its contact is made below approximately 10 m.p.h., at which point the relay G is engergized. This causes contact G_1 to connect the clutch circuit to the dynamo, and contact G_2 to insert series resistors R_1 and R_5 into the dynamo field circuit, at the same time providing the field coils with a small battery feed through resistor R_2. As the car speed rises the governor contact breaks, G_1 changes over to feed the clutch from the battery (via the ignition switch), and G_2 removes the dynamo field circuit modification. The action of G_1 permits tow starting.

Mercury switches which are sensitive to fore and aft accelerations, are installed in the control box and have contacts which are broken when the car is accelerating. As a single switch would be affected by cornering acceleration, two switches placed at 20 deg to each other are used, these being connected in parallel across resistor R_3. The function of these switches is to reduce the excitation current when the car is not accelerating, in order to limit the value of the accelerating torque which the clutch can transmit and so smooth out light or closed throttle gearshifts.

To cater for the condition when the engine has a high torque value with no forward acceleration on the car—that is, maximum speed—a top gear switch with contacts which make in top gear is connected across the mercury switches and the resistor R_3. The gear shift switch is installed in the pivot end of the gear lever, and contact is made when a load is applied to the lever knob. This causes the C relay to be energized. Contacts C_1 and C_2 change over and, in effect, reverse the polarity of the clutch coil. A small reverse current is provided through resistor R_4 to nullify the effects of hysteresis.

A switch actuated by a gear lever operated cam makes contact in neutral, and energizes the C relay via the governor to free the clutch in neutral below governor speed. To complete the system, there are two other switches and a relay—all unique in their application. One is a throttle switch controlling the relay T. When the throttle is closed, the switch causes the relay to become energized. The relay has a change-over contact T_1, the lever of which is connected to the moving contact G_1 which, in turn, swings between the normally made contacts—that is, connected to the dynamo and the normally broken contact that is earthed.

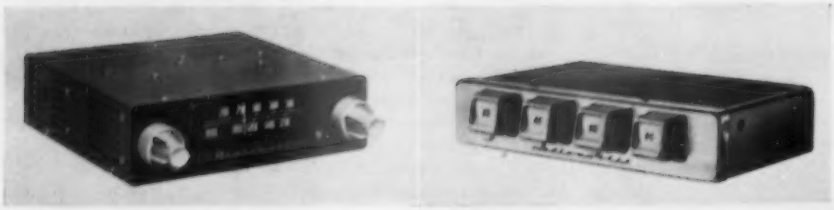
Energization of the relay below governor speed results in an interruption of the clutch current, followed by a slow clutch release owing to the earthing of the clutch coil. This slow release of the clutch prevents the sudden unwind of the transmission. When energized above governor speed, the relay opens the T_2 contacts which are in series with the top gear switch. This results in a reduced excitation of the clutch owing to the resistor R_3, thereby achieving a degree of current economy.

The remaining switch introduces a further resistance R_5 into the dynamo field circuit when the choke is in operation, thus catering for the greatly increased idling speed under this condition.

Smiths have done considerable development work on this system and have followed two courses in their progress towards fully automatic transmission. The first is a semi-automatic system whereby the manual control system described above incorporates also a degree of servo-operation for gear shift, partially under the control of the driver but relieving him of the duty of moving the gear lever. The second is a fully automatic system which will provide for the driver, if he wishes, a measure of individual control over gear shifting; he can, on the other hand, leave his transmission operation entirely to a form of automatic pilot. This system, the development of which is well advanced, is to be called the Autoselectric system.

Two new power-operated drop-head actuating systems are designed and manufactured by the Commercial Ignition Co. Ltd., and Smiths Jacking Systems Ltd., respectively. The Commercial Ignition system is a self-contained electro-mechanical unit comprising a motor with limit switches, a

The Wingard Sahara car heater, complete with all its fittings, except the rubber hose connections



New Smiths Radiomobile car radios. Left, the model 20X medium and long wave, single-unit receiver, and right, the model 30X short wave converter unit

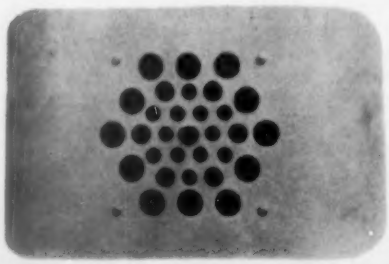
The Packard Patrician is an example of rear-mounted, twin telescopic aerials. Both aerials can be extended and retracted, and the control is so placed that it can be easily operated by the driver

magnetic brake to limit over-run and patent reversing switch to avoid trouble if both up and down controls are operated together, and the actuating mechanism. The unit requires only one supply cable and a three-core cable for control switches, in addition to an adequate earth. Performance is such that 1,000 lb thrust or pull can be exerted over the normal stroke of 6in in an average time of 15 sec. Consumption from a 12-volt supply is 30–35 amp—¼ amp-hr per operation.

The Smiths system is electro-hydraulic. It enables the hood to be automatically raised to, and locked in the de ville position, after which unwinding and fastening of the hood to the screen top is done by hand. The unit consists normally of two jacks for raising and lowering the hood and one jack for pushing the rear seat squab forward for ease of stowing. However, the equipment can be supplied with two additional jacks that will lock the hood in position, or alternatively, locking can be performed mechanically. The motor, pumps and pipe lines are compactly arranged on a panel, which can be mounted out of sight beneath the rear seat.

Heaters and radios

There were, of course, the usual ranges of heaters manufactured by Delaney Gallay, K-L, and Smiths. Of the new heaters exhibited, one is British and the other German. The British unit, manufactured by Wingard, is called the Sahara. It is designed to suit the majority of medium-size family cars, although on maximum boost it is adequate for larger cars. The radiator, of cylindrical construction with wound and finned tubes, is highly efficient. The fan is designed to provide maximum flow for heat circulation, at the same time adequate flow through the demister and defroster tubes. Its efficiency is claimed to be such that a special defrost control is unnecessary. A rheostat switch is provided, and the motor—1/250 h.p.—runs at 2,000 r.p.m. on Oilite, self-lubricating bearings. A control valve permits water circulation to be stopped during summer, so that the



Pye Continental car radio for long-distance reception. Five wave bands are obtainable: long, medium and three short

fan may be used for car cooling and ventilating purposes only.

The Bosch heaters, termed types XY/BA and XY/UA respectively, are both of the wound, finned tube variety, the former for normal facia panel mounting, and the latter designed for underseat fitting. Both are of high efficiency.

Notable among the car radios were the Philco and Phillips ranges, the Pye Continental model TCR and recently announced range, including the first transistorized model on the market outside the United States, and two new Smiths models. The Pye Continental model TCR 13/14 is a six-valve unit, specially designed for long-distance reception. It covers five wavebands—three short, one medium and one long—and it is available for both 6- and 12-volt systems. The transistorized model, the TCR 16, is a powerful, high fidelity set, compact and requiring only ¾ amp from a 12-volt battery—it is not available for 6-volt supply. A power transistor replaces the usual vibrator to supply high voltage for the valves, which are used in the radio-frequency stages. Power transistors in push-pull are utilized for the audio-frequency output, which is claimed to be 4 watts for one loudspeaker and 6 watts for two. Pye also exhibited a transistorized electronic loud hailer or megaphone, and a selection of radio-telephone equipment especially suitable for use in cars.

Notable in the Smiths range was the new 20X which comprises only one unit in addition to the loud speaker and an aerial. There has been no sacrifice of quality of reproduction, and an automatic volume control gives continually sensitive response. The other new model is the 30X, a short wave converter for use with any car radio. It is housed in one small unit and has four removable plug-in coils; a switch mechanism selects the appropriate coil for a particular waveband. Eight of these interchangeable coils are available giving approximately 1 megacycle coverage in 16, 19, 25, 31, 41, 49, 60 and 90 metres broadcast wavebands.

Smiths Radiomobile, in co-operation with a number of leading coachbuilders, have installed E.M.I. Minifon wire recorders in the armrests of passenger seats of custom-built models. The wire recorder is linked with the radio installation, and any dictation can be played back immediately through the loudspeaker in the passenger compartment without its being heard by the driver.

A Marconi radio telephone, set into the nearside facia locker of a Rolls-Royce Silver Cloud saloon, was to be seen on the Harold Radford (Coachbuilders) Ltd. stand.

In addition to many cars fitted with Ekco car radio, several had the Ekco portable television/radio receiver installed. On the stands of Rolls-Royce and Park Ward Ltd., were limousines incorporating a specially styled receiver of this kind.

An American trend in the location of car radio aerials is to have rear-mounted, twin telescoping aerials, controlled from the driver's seat; one example was to be seen on the Packard Patrician.

Coachwork

Trend Towards Rationalization Continues; Increasing Interest in Air Conditioning

IT is usual to visit the Motor Show at Earls Court expecting to find several features that are entirely new, and possibly revolutionary. This has certainly been the case since the War and it will be recalled that last year there were a number of new models, which since have been seen in increasing numbers on the roads. It is evident, after an examination of the various exhibits and bearing in mind coachwork and styling matters, that the post-War trend to establish new ideas has lost its impetus and that manufacturers appear to be content to rely upon models that have become established during the past few years. These remarks apply only of course to major design issues, for one of the outstanding features of the recent Show was the care and attention that has been given to the development of minor modifications, which are of definite value to the driver and passengers.

There was to be noted also an extension of the principle of using existing pressings combined with new components to create a new style. In this connection the evergrowing popularity of the estate car is evident. All the large manufacturers now include an estate car conversion in their range, and this versatile type of vehicle is becoming increasingly popular. In the past it has been found that there was a tendency for refinements to be neglected in this type of vehicle, but manufacturers appear to have given more thought to this point, and it is hoped that any new models now appearing will maintain the degree of silence and freedom from draught that is expected in the contemporary private car.

Brighter colour schemes were prevalent and the two-tone finish was almost universal on both closed and open vehicles. Some manufacturers appear to have made a very close study of American trends in external decoration, and the over-liberal use of chromium is not always so pleasing as the stylists might wish. It was noted that this tendency does not extend to coachwork in the special category, where the styling remains restrained and the interiors luxurious.

Perhaps one of the most interesting features of the Exhibition is the adoption of full air conditioning equipment

Standard Vanguard estate car developed from the Vanguard III. The tailboard incorporates a built-in toolbox

On the Martin Walter Dormobile conversion of the Vauxhall Velox, the rear quarter lights are extended forwards to follow the door shut line. This enhances the appearance of the vehicle

on certain export cars—a worth while development that may well be extended to other products for overseas markets. It does appear, however, that there is a demand for British air conditioning equipment and this, in view of the work that has already been done successfully on heavy passenger-carrying vehicles and railway stock, should not present a very great problem. There is a small increase in the number of cars equipped with television, but it is not anticipated that such equipment will figure largely in the specifications of medium-size cars.

Last year the Standard Vanguard was the subject of considerable external changes, the most notable feature of which was the continuation of front and rear wings over the door panels, of which they form part. It was not, therefore, to be expected that this company would introduce further changes in this model. What has been done, however, is the development from the basic structure, of a very attractive estate car that will undoubtedly find wide support. Externally this estate car retains the lines of the private car below the waist line, but the upper portion of the body is extended rearwards behind the rear seats to provide a roomy luggage compartment of full body depth in place of the conventional luggage storage space of restricted height found on the normal version.

The estate vehicle has a rear panel containing above the waist an upwardly hinged lid, and below the waist a tailboard that embodies a built-in tool box. As is usual in estate vehicles, the rear seat squab is hinged forward to be disposed between the front seat squab and the rear seat cushion, which, when turned over, increases the floor space and gives a completely level luggage disposal area of considerable length. The fuel tank is installed beneath the rear portion of the floor, and provided on the near-side with a fuel cap that may be securely locked. The spare wheel is carried in a hinged cradle beneath the fuel tank.

In addition to the conventional door windows, each of which has a hinged ventilation panel, there is a long quarter-window which is fixed. The large rear window is curved to conform to the transverse contour of the body at this point.

Revised moulding treatment on the Vauxhall Cresta

When the body is used with the tailboard lowered, as it is when a long load is being carried, the number plate may be hinged downwards to retain its vertical position. In other respects the Vanguard estate car follows the general lines and finish of the private car version, particularly with regard to details of the front compartment, which has a full-width seat.

Another addition to the Standard range is the sports version of the Vanguard III. The two models are similar in outline but the sports version has detail modifications, the most noticeable of which is the plated moulding strip along the body side, the low rectangular grille, and the two-tone colour scheme. The headlamps are hooded, in conformity with the current trend. It will be interesting to see what effect the new regulations, which are being introduced on the Continent, with regard to projections on the front ends of cars, will have on this trend.

Another manufacturer of popular, medium-priced cars has made only minor modifications to existing models, but has extended the range by the addition of two estate vehicles. Thus, Vauxhall Motors Ltd. now offer two conversions of their Velox model, one conversion being the well known Dormobile produced by Martin Walter Ltd., and the other, an estate vehicle by the Grosvenor Carriage Co. Ltd. Of

Distinctive treatment of the rear quarter and side light on the Austin Princess IV saloon by Vanden Plas. The rear end is shaped to provide a large rectangular space for the accommodation of luggage in the boot

these two models, there is little doubt that the Dormobile presents the most attractive appearance, permitted by forward extension of the quarter-window to follow the rear door shut-line. This treatment gives the vehicle a long window span and creates an impression of length. The Grosvenor conversion, on the other hand, has a quarter-window with a front line curving towards the rear, thus creating a blind panel of increasing width towards the top, which effectively breaks up the continuity of the window span. This arrangement does not materially affect the convenience of the driver in the matter of visibility and is no worse than the conventional four-door, four-light saloon, but in comparing the two new estate vehicles the lighter effect of the Dormobile upper structure is immediately apparent. The Grosvenor has the advantage, of course, that this blind quarter panel provides a greater measure of strength and rigidity. The rear seat arrangement in the Grosvenor enables the seat to be hinged in such a way that it forms a bed, or alternatively, can be disposed to provide maximum luggage accommodation behind the front seats. The third position follows the normal seating arrangement.

On the private car versions of the Vauxhall range, the principal external changes are concerned with moulding decoration, and in this respect it is perhaps, difficult to find a reason for the downward turn of the lower moulding used on the side panel. The downward turn occurs immediately after a horizontal run from the front of the car to the rear pillar, the slightly inclined downward turn being followed immediately by a short horizontal section to lead into the upswept portion, which follows the wing line. This contour is undoubtedly distinctive but would appear to depart from the clean continuous lines that characterize the Vauxhall models. Another small point is a modified rear lamp unit incorporating a plated cowling which houses all rear lamps other than that those needed to illuminate the number plate.

One of the few entirely new cars in the Exhibition was the Austin Princess IV saloon, on which the bodywork is by the associated firm of Vanden Plas Ltd. This luxurious Austin vehicle is essentially modern in appearance with external lines characterized by the full flow wing treatment relieved by a falling swaged line passing across the door panels and sweeping upwards over the rear wheel. A curved screen is fitted with self-parking wipers. In the design of the rear doors and quarter panels a rearward inclination is adopted for the upper portions of the pillars to give maximum door width at shoulder height and to facilitate entry to the rear seats. Below the waist, the rear door shut-line is vertical for a short distance. This vertical portion accommodates the lock mechanism, while below this point it is necessary to sweep the door forwards following the wheel arch line. The positioning of the seats is such that all passenger weight is well within the wheelbase, the rear seat being so arranged that the cushion has no cut-outs to fit round the wheel arches.

It might perhaps be considered that the rearward inclination of the upper rear door line would appear incongruous, but this is definitely not the case, owing to the fact that the angle adopted harmonizes with the rake of the screen pillars. Since the pillars in each door are not parallel, a portion of the glass is arranged as a pivoting ventilator, thus making possible the use of parallel runs for the glass. The runs in the rear doors are so arranged that a complete drop window is provided while the ventilating portion is immediately over the door spur.

Reference has already been made to the forward location of the rear seat and apart from the improvement in weight distribution that this mounting provides, it also makes possible the provision of a roomy luggage compartment. On the Austin Princess IV the compartment provides a capacity of approximately 13½ ft³. In order to make the best use of this compartment, which has a lift-up lid with balanced mechanism, fitted suit cases are available and comprise both large and small units. As is often the case with more expensive production cars, both saloon and limousine versions make use of the same basic body shell. On the Princess, the body shell is of steel while in the interests of weight reduction non-stressed panels such as the bonnet and luggage compartment lid are of aluminium.

For the saloon version, individual front seats are close-mounted to make possible the accommodation of three passengers, the armrests in each seat providing, when

Left: Rationalization to reduce costs is a feature of all the Rootes Group range of cars but, despite this, the traditional radiator grille is retained in the front end treatment on the Singer Gazelle saloon

Right: A noteworthy feature of the Singer Gazelle saloon is the wide rear light, through which the driver has an unrestricted view. The petrol filler and boot lid lock are on the rear skirt panel

On the Austin A95 estate car the lower portion of the two-piece rear door forms a tail-board, to provide for the accommodation of extra long loads

Right: The Sunbeam Rapier, which was shown for the first time last year, maintains its popularity. Its styling is among the best, so far as the world's quantity-produced cars are concerned, and is representative of current trends in design

Left: The rear lamp arrangement on the Vauxhall models, as modified to incorporate reflectors to meet British legal requirements

Despite its small size, the Goggomobil is a four-seater car of conventional layout, except that its engine is at the rear

The rear end treatment of the Buick Centurion incorporates flared wings and the general arrangement is not unlike that of the more conventional Boano Ferrari, exhibited at the Geneva Show earlier this year

Good all-round visibility is a noteworthy feature of the Goggomobil

lowered, a wide centre unit, which is supplemented by armrests on the front doors. In the limousine body, the one-piece front seat has an electrically-operated division glass. All seat cushions are of exceptional depth, comfort being ensured by the use of foam rubber as a foundation for trimming. The rear seat, as is usual in the more expensive vehicles, has a folding centre armrest. Except where bucket type seats are used, a central armrest is almost essential, to help the passengers to keep in their places.

Among other cars displayed by Austin, the only entirely new model was the new A95 estate car which has a double-opening arrangement in the rear panel, comprising a lift-up section above the waist and a lower portion that can be fixed horizontally to accommodate lengthy loads. The private car version of the A95 has a body which is longer and lower than hitherto—a trend which has also been followed on the A105 model.

The company of Donald Healey Motor Co. Ltd. showed an improved version of the sports model, which forms the main production of the company. To increase this model's usefulness, it has been found possible to provide two small rear seats by slightly reducing the luggage capacity. These two small seats, which are semi-circular in shape, are intended primarily for two children, although it is possible for one adult to occupy the space available on a short journey. The Austin-Healey is an attractive sports car with full-flow wing treatment and a pleasing side moulding sweep between front and rear wings which makes possible an attractive two-colour scheme, in which the panel surface below the moulding is finished in one colour and the entire upper portion of the body, together with all the front surface, is finished in an alternative shade. In addition to the normal weather protection that characterizes an open sports car, it is now possible to obtain a detachable hard top for this model.

Although classed as a new model in so far as Singer Motors Ltd. is concerned, the Singer Gazelle is really a combination of the Singer engine and body components associated with the Rootes Group. The Singer Gazelle thus follows well-known lines and comprises a medium capacity body shell of integral construction. There is a neat radiator grille and the side panels incorporate a chromium plated moulding extending from front to rear, thus forming a suitable line of demarcation for the two-colour scheme. To distinguish it from models of similar size, the interior has a high class finish with solid walnut cappings and finishers, which add refinement.

In addition to the four-door saloon, there is a convertible with a three-position head, the intermediate setting being the de ville position. It is noticeable that with the head completely folded it falls neatly into a recess surrounding the rear seat. In this two-door convertible body, the one-piece front seat has a divided squab so that either side may be hinged forwards to simplify access to the rear seats.

A small refinement has been introduced on Rover cars to permit the driver to determine whether his side lights are on, as the position of these side lamps is such that without reflection it is impossible to ensure whether they are functioning. For this purpose a small chromium plated projection is mounted at the front of the wing catwalk, where it is visible from the driving seat and where it will also reflect light from the side lamps. Apart from detail modifications current models produced by the Rover company remain unchanged.

This Aston Martin, two-door fixed head saloon with bodywork by Tickford, has a large capacity luggage boot

Air conditioning plant is installed behind the rear seat squab of the Lincoln Landau. Access to this equipment is gained through a trap in the shelf between the top of the squab and the rear window. An interesting feature of the installation is the large diameter tubes of transparent plastics, which extend upwards from each side of the shelf and are curved forwards to register with the rear ends of the ducts that extend parallel to the cant rails on each side

Adjustable head rests are fitted to the front seats of the Buick Centurion and the television screen on the dash is used instead of a rear view mirror to give the driver a good view of the road behind

In the Morris range, only minor modifications have been made, the Morris Minor for example, now known as the Minor 1000, having a curved screen in place of the V-screen previously used. Amongst the other modifications to be noted on this model is a restyled instrument layout. Slight external styling changes have been made in the Morris Cowley and Oxford, which now have greater slope on the bonnet panels.

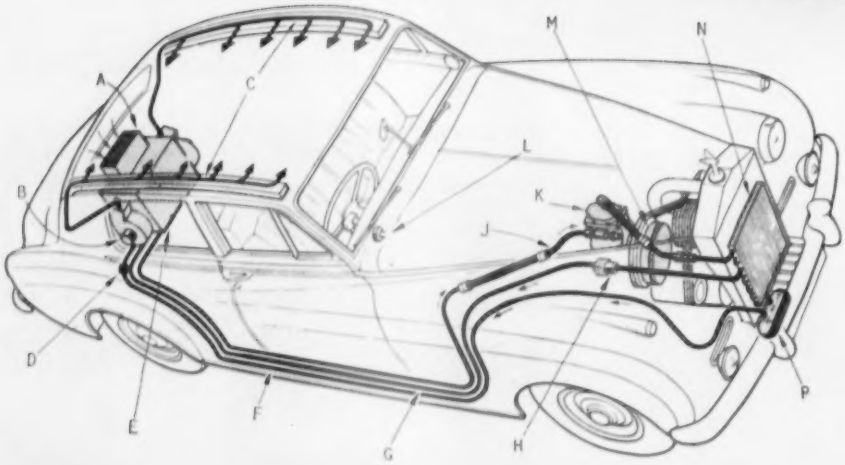
The production of an English-built body using Swiss styling is exemplified in the Alvis TC108-G. This design, which appeared for the first time last year, is by the well known Swiss concern of Graber. The body is now being produced in this country by the firm of Willowbrook Ltd.

Typical sports car coachwork was to be found on the Aston Martin 3 litre chassis, carrying a two-door streamlined saloon by Tickford Ltd. Reference has previously been made to the inclined rear line of the quarter window, and here was to be seen another example in which this treatment has been adopted, the window line being parallel with the rake of the screen.

The Jaguar is another make which is available in special form to meet the needs of those requiring a car of distinctive appearance and furnishing. The new Jaguar Mk. VIII is a production car that closely rivals the products of many specialist coachbuilders. This latest model is basically the same as the Mk. VII, but provides luxurious upholstery which can be modified to suit individual tastes. For example, the front seating can either be of the one-piece bench type or can be arranged as individual seats. The 2·4 litre model, which was introduced last year, is continued without major alteration. Similar remarks apply to the Jensen, notable for a reinforced glass fibre saloon body the use of which affords considerable weight saving—an essential feature where high performance chassis are concerned.

An entirely new vehicle that was announed only a short time ago and which attracted considerable interest is the Berkeley sports car. This is a low-powered model with the engine and transmission units at the front of the car. The point that the coachbuilders find of particular interest, however, is the extensive use of glass reinforced polyester resin as the basic material for the construction of both body and chassis. In adopting glass-polyester the manufacturers were undoubtedly influenced by their wide experience in the use of the material for the construction of caravans, a form of vehicle that has been the company's main pre-occupation since the war. The use of reinforced laminate has permitted box section stiffening to be embodied in the

Deeply recessed housings accommodate the headlamps in the Buick Centurion



A *Circulated air returns through a grille in the parcels shelf,* **B** *A centrifugal blower unit is fitted on each side,* **C** *Cooling air ducts built into the cant rails,* **D** *Expansion valve,* **E** *Evaporator unit in boot,* **F** *Refrigerant pipes in the body sill,* **G** *Control line,* **H** *Solenoid valve,* **J** *Warm, low-pressure gas,* **K** *Two-cylinder compressor,* **L** *Three-position blower control,* **M** *Magnetic clutch,* **N** *condenser in front of radiator block,* **P** *Liquid receiver and drier mounted on chassis frame*

Air conditioning system of the Rolls-Royce Silver Cloud and Silver Wraith models

punt-like under-frame which is suitably reinforced where necessary by light alloy members. The entire body shell is constructed as a unit to fit over the base frame and provides a light-weight structure which is so essential when such low rated power units are contemplated.

The body layout is primarily concerned with accommodation for two adults, but a detachable decking behind the two front seats reveals two small seats which can be used for the accommodation of two small children or for luggage. As an alternative to the normal folding hood a moulded glass-polyester hard top is available.

Of the Continental cars, those which attracted attention have in general been seen on previous occasions, this remark applying particularly to the Citroen DS19 which has so many advanced features. In view of the attention now being devoted to luggage accommodation, especially when the full seating capacity is not required, mention must be made of the Mercedes Benz 220S coupe in which the rear seat cushion and squab can be folded down to give a roomy level disposal area for excess luggage. This arrangement, which is very neat and incorporates a side locking device, forms a useful addition to the enclosed luggage compartment provided at the rear.

An entirely new approach to the design problem of convertibility, in which seating and luggage space may be varied to suit prevailing demands, is to be found in the new Fiat 600 Multipla. This exhibit occasioned much interest and although it has perhaps, a general external appearance that is closer to a light commercial vehicles than to a private car, it possesses so many practical features that one is inclined to overlook the absence of conventional private car proportions. In the design of the body there are two wide doors on each side, these being hinged on the central pillars. Since the engine and other major chassis units are mounted at the rear, there is no necessity for a bonnet, and the front bulkhead is continued upwards towards the roof by a curved screen. The car has a six-light body with a large back light and the unobstructed space within the body is such that for full seating capacity three transverse rows of seats are possible, giving accommodation for six passengers including the driver. With this arrangement the front seat, as in alternative schemes, is of the conventional bench pattern while the four seats that follow are of the collapsible bucket type. Even with this arrangement there is room for luggage disposal behind the third pair of seats. A second arrangement is one in which two bench type seats are used to accommodate four or five persons, giving a correspondingly greater luggage accommodation behind the second row of seats. A third scheme retains only the front seat, giving a maximum degree of luggage accommodation. In this form it is quite conceivable that the Fiat 600 Multipla would prove attractive to the tradesman, for the goods storage space made available is readily accessible through the wide side door and loads up to 770 lb may be carried.

In striking contrast to the majority of cars in the Exhibition was the Goggomobil, a small rear-engined vehicle with accommodation for two adults and two children. This car is of very compact dimensions, having a wheelbase of 70·8in, while the concentration of mechanical units at the rear enables full advantage to be taken of the clear floor space left available. The body is attractively styled and is of all-steel construction, with front and rear wings that are faired into the side panels. As an alternative to the fully closed model, the roof may be provided with an opening section, a style that has found favour abroad for a number of years.

The American cars on display were in distinct contrast to the standard productions from this country, for without exception the American cars are large and very elaborately equipped. Despite their ostentatious appearance, which is not readily accepted by motorists in this country, they repay close investigation, for the ideas that are to be found can with modification be applied with advantage to our products. A case in point is the air conditioning unit provided on the Lincoln Landau, which is located in a full-width compartment behind the rear seat squab. Access to this equipment is through a trap formed in the shelf normally found between the top of the squab and the rear window. An interesting feature of this particular installation is the use of large diameter plastics tubes, which extend upwards at each side from the shelf and are curved forward to register with the rear ends of the cant rail ducts. It would appear that the reason for these transparent curved ducts mounted on the rear shelf is that there is a wraparound rear window, which leaves only a small section of blind quarter panel. Conditioned air is expelled from the cant rail ducts through openings at each corner of the roof.

Refrigeration installation in the boot of the Rolls-Royce saloon

A point that is particularly noticeable on most American cars is the manner in which the screen formation has led to the adoption of door hinge lines of unusual shape. This trend is mainly due to the use of a wraparound screen which necessitates positioning the upper screen pillar further to the rear than in the past. For example, on the Mercury Montclair, the door line position is governed by foot space when entering or leaving the car, and is therefore well in advance of the screen pillar which has a forward inclination to meet a front top rail which surmounts the well-inclined, wraparound screen. Thus it is necessary for the door line to have pronounced rearward curvature to meet the base of the screen pillar. This arrangement appears to be quite normal on American cars and is, in fact, to be found in more restrained form on some British products. The main problem that it introduces is the provision of adequate stiffness to prevent damage to the glazing.

Another pronounced feature of American coachwork, and one which is gradually extending to this country, is the extreme depth of the rear wing ends. There are two main reasons for this treatment. It has been found that on cars capable of high speeds, such treatment is essential if lateral stability is to be maintained: in practice, by continuing the crown of the rear wing towards the rear end without reducing its height, an effective fin is created which has a marked stabilizing effect. The second reason is that the deep wing end thus formed provides suitable accommodation for the elaborate rear lighting equipment now popular. While considering this rear wing formation, in general it can be said that it forms an essential part with the horizontal mass treatment that is now so frequently found, although it is true that the American body, with its greater length and larger panel areas, illustrates the treatment to the best advantage.

Advanced ideas far in excess of present day demands made an interesting study on the Buick Centurion, which was exhibited as a prototype and which contains features that some day will undoubtedly be in the specifications of the variety of models made by this concern. Reference has already been made to the use of television for the convenience of passengers in certain British cars, but in the Buick Centurion the principles of television have been employed to provide the driver with a view of the road behind. The wing treatment used on this advanced car has a somewhat heavy appearance when viewed from the rear, the inner valances of the wings being rather wider than usual to fill the space between wing and tail panels on each side of the vehicle.

The special coachwork section reflected the same general theme as the stands occupied by chassis manufacturers, in that there are few entirely new features. There are, of course, modified versions of established models, but such modifications are slight and apart from one new development, it is impossible to establish a trend for future productions. The one point that does emerge from a close examination of the products of specialist coachbuilders is the adoption of a full air conditioning installation, which in this particular case has the backing of the chassis manufacturer. This scheme is the one that has the support of Rolls-Royce, who are now in a position to supply fully air conditioned cars for export purposes. On the manufacturer's stand a Park Ward touring saloon was displayed, in which was installed an air conditioning plant of American origin. As on the Lincoln already referred to, the air conditioning unit is mounted behind the rear seat squab in a 10in long compartment extending the full width of the body. The compartment is sealed off from the luggage compartment by a bulkhead, in which a hinged lid is provided for access to the unit for maintenance purposes. An essential component of the unit is the compressor which is driven from the fan pulley. When not required the compressor can be disconnected by the operation of a magnetic clutch. Conditioned air is fed from the unit into ducts formed along each side adjacent to the cant rails. In the Park Ward body the conditioned air is released to the seating compartment through a narrow gap which extends the entire length of the body at each side of the roof lining. An important requirement in the design of these systems is the avoidance of cool draughts inside the car, since these will cause discomfort to the passengers. When in operation the compressor absorbs 5 h.p.

On the Park Ward stand, the coachwork exhibited followed very closely the examples that were seen last year and in addition to the Bentley Continental coupes which include both drop-head and fixed-head models, there was a Rolls-Royce Silver Wraith seven-passenger enclosed limousine, which is noteworthy for the installation of a television set. The installation, which includes a VHF radio, is by Ekco and is situated in the centre of the division, from which it can be removed when required since the instrument is arranged to operate on mains voltage as an alternative to the car's 12-volt system.

Television installation on a Rolls-Royce limousine by Park Ward

A model specially developed to attract attention in America is the Rolls-Royce Silver Cloud drop-head coupe built by H. J. Mulliner Ltd. This extremely attractive four-seater body is noteworthy for its electrically-operated head gear. The hood works efficiently and, when lowered, is extremely neat, being practically level with the surrounding body panels. As with so many H. J. Mulliner vehicles, all-metal light alloy construction is used, a system developed some years ago by this coachbuilder.

An outstanding car on the Hooper stand was the four-door saloon on a Bentley S Series chassis. As in the past, the builders have adopted the long, swept front wing, which merges into the body side panel. Owing to the width of the body at the rear, no separate rear wing is necessary and the body is fitted with a detachable shield, which encloses the wheel arch cavity. Mention should be made of the headlamp housing which is incorporated in the front wing and has a pronounced cowl above the lamp.

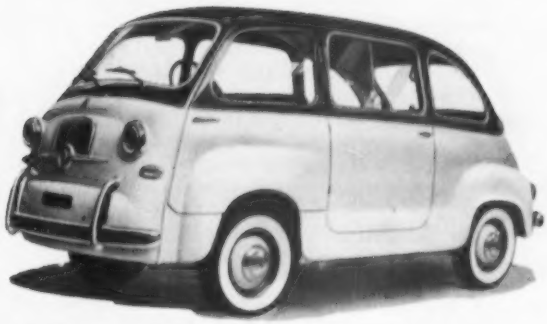
A new Bentley S Series design exhibited by Freestone and Webb is a four-door six-light saloon displaying well balanced lines. There is a curved screen and the head lamps are accommodated in the front wings, which merge into the body side panels. The headlamps are fitted in the forward face of the wings, which are contoured to give a slight hood over the lamps. Other features include a capacious luggage boot and a wraparound rear light, which leaves only a short quarter panel.

Arrangement of the sunshine roof incorporated by Harold Radford (Coachbuilders) Ltd. on their Bentley Countryman

The excellent proportions and well balanced lines that are associated with the products of James Young Ltd. were to be found in all their cars displayed and, in particular, the carefully modulated line of the wings repaid close study. This coachbuilder also relies upon traditional styling and a form of body construction comprising a combination of steel and light alloy materials.

Not many years ago a saloon car without a sunshine roof was a rarity at the Exhibition, but since the war there has been a steady decline in the use of this fitting and today it is seldom seen. On the Harold Radford stand, however, the Countryman saloon exhibited on a Bentley includes a Continental style of flexible sunshine roof, which gives a large opening above both front and rear seats. There

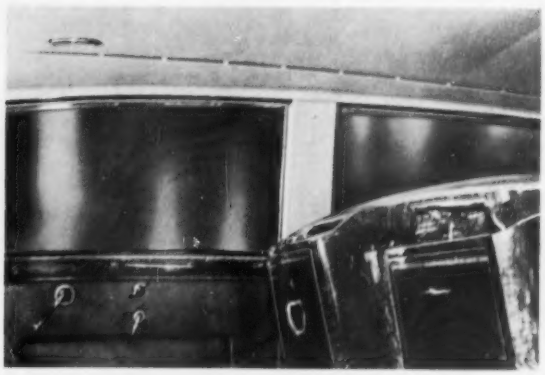
An interesting detail on the Rover cars is a chromium plated projection, above each headlamp, which gives a reflection to indicate that the side lamp is on



The Fiat 600 Multipla can carry six passengers or 770 lb of goods

An Aston Martin car with a body styled by Touring of Milan

Above: On the Mercedes Benz 220S coupe the rear seat can be folded, as shown in this illustration, for the carriage of extra luggage



Left: On the Park Ward Rolls-Royce Silver Wraith, there is an outlet for conditioned air at each side of the roof

Right: Modern lines are combined successfully with a traditional radiator grille on this drop head coupe, which is built by Park Ward and Co. Ltd.

would appear to be little difficulty in extending this opening device back to the middle rail, although in the case of the Countryman saloon the back light and panel surface surrounding it is hinged upwards for luggage disposal. In all other respects this versatile type of body remains unchanged.

After a careful assessment of the many bodies exhibited it is impossible to detect any marked deviation from accepted practice, either in design or construction, that might influence future production. In design, the full-flow wing or something approaching it is almost universal and traditional individual components are definitely out-dated.

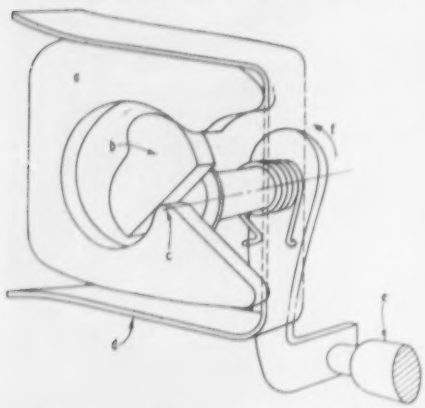
Similar remarks apply to the bonnet having double curvature although some models are still to be found with transverse curvature only, but here it is largely a matter of tradition and changes will occur more slowly. The general practice is for doors to be hinged on their forward edges and the time is coming when more extensive use will be made of the curved screen with wrap-round edges. The use of this type of screen will necessitate major modification to the front door hinge pillars as on current American productions.

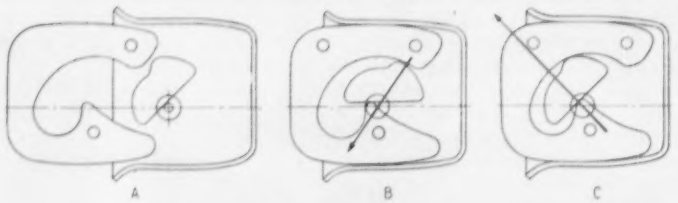
In construction, the use of light alloy members is now widely followed, both extrusions and castings being employed. The only development which is likely to interfere with traditional procedure will be the extension of the use of plastics, but this seems to be slow in making headway and has so far attracted only small producers. Little has occurred to influence luggage disposal and the only remark to be made in this connection is that the installation of air-conditioning equipment has necessitated some slight reduction in luggage-carrying capacity. Air conditioning equipment is fitted only in a few cases, these all being large cars which still have ample luggage capacity.

The Zero Torque lock, introduced recently by Wilmot-Breeden Ltd., has not yet been fitted as standard equipment on any production car, because the development work on it has not reached finality. However, it has already undergone extensive tests, and the indications are that it is perfectly satisfactory in operation and has many advantages over the more conventional types of lock. Unlike the locks commonly employed at present, the new one does not need any ancillary device to provide vertical restraint.

As can be seen from the illustrations on this page, the three essential elements of the Zero Torque lock are: a rotary cam, and the striker and guide plates. The cam and striker are so shaped that the process of engagement is irreversible from the safety position onwards: in other words, there is no direct torque applied to the elements in restraining the door from opening. Apart from the safety feature that this implies, the arrangement also has the advantage that the mechanism required to actuate the lock is extremely simple: only a device to release the elements is needed.

In the set of three illustrations on the right, A represents the approach position of the elements. The guide plate and the external periphery of the G-shaped striker are such that, should the approach of one element to the other be incorrect, it is rectified before their full engagement. At B, the first safety position is shown. Partial restraints only are provided, the door being allowed restricted horizontal movement to give a warning rattle. The fully locked position is shown at C. In this position, horizontal and vertical restraints are provided, the latter being obtained by virtue of a wedging action between the cam and the striker.





*In the diagram on the left, **a** is the striker, **b** the rotary cam, **c** the centre of locking radius, **d** the guide plate, and **e** the pushbutton. The arrow shows the direction of spring loading*

Quietness of operation is a feature of the Wilmot-Breeden Zero Torque lock, which cannot be overslammed. The unit will function effectively even if the spring should break. The arrows in the diagram above indicate the direction of the resultant force on the cam: they pass through the centre of rotation

The advantages of the Zero Torque principle are as follows. Engagement of the elements drives the rotary cam into the locked position, and the action is irreversible. When the door is closed, its security does not depend upon the engagement of secondary elements or on spring action. If the spring fails, the locking action is not affected. Lack of lubrication does not significantly affect locking, which is unimpaired even after considerable wear has taken place. All vertical motion is effectively restrained. The components are simple and there is no internal locking mechanism. It follows that maintenance is easy. Entry of dust and grit into the mechanism does not materially affect its operation. The load that is necessary to release the push-button is relatively unaffected by seal pressure.

A high rear wing treatment is a feature of this Freestone and Webb Bentley saloon

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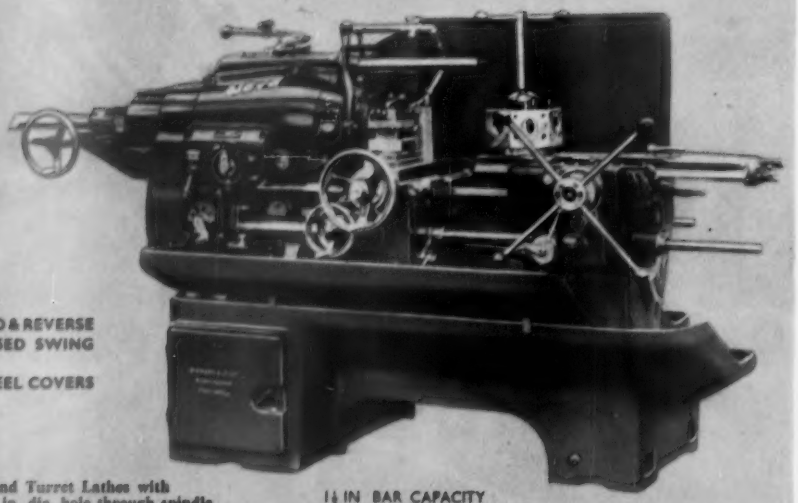

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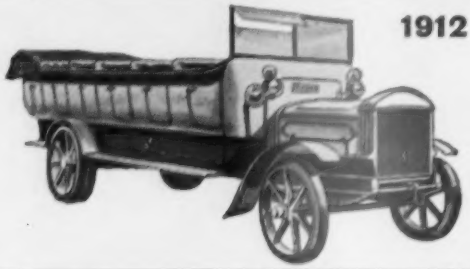

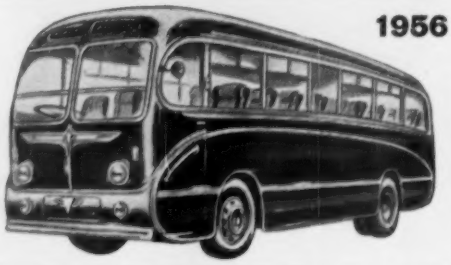

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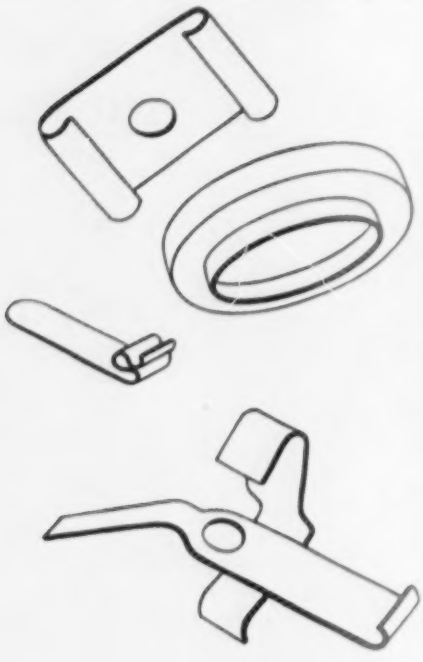

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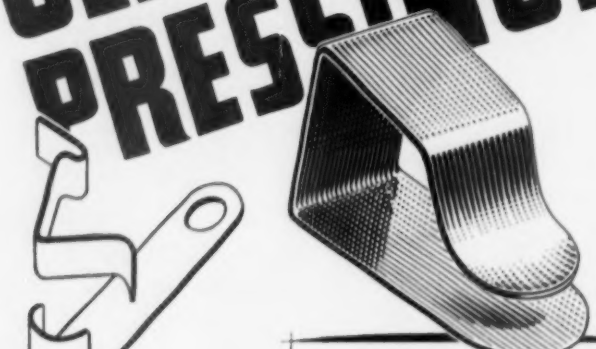

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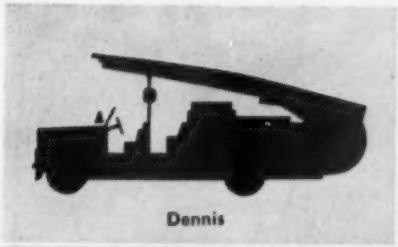

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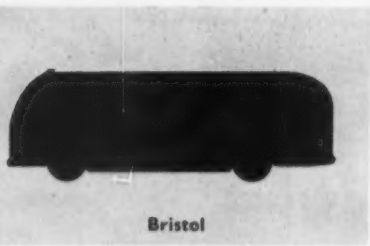

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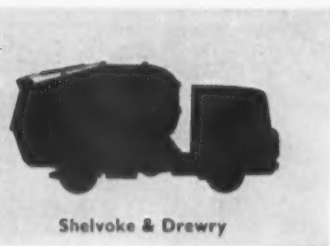

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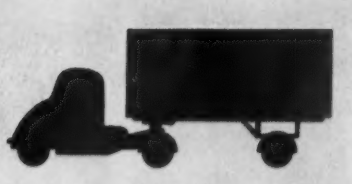

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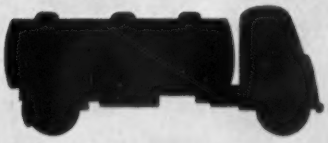

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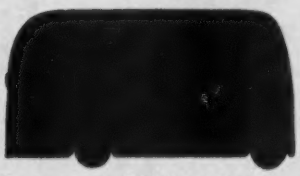

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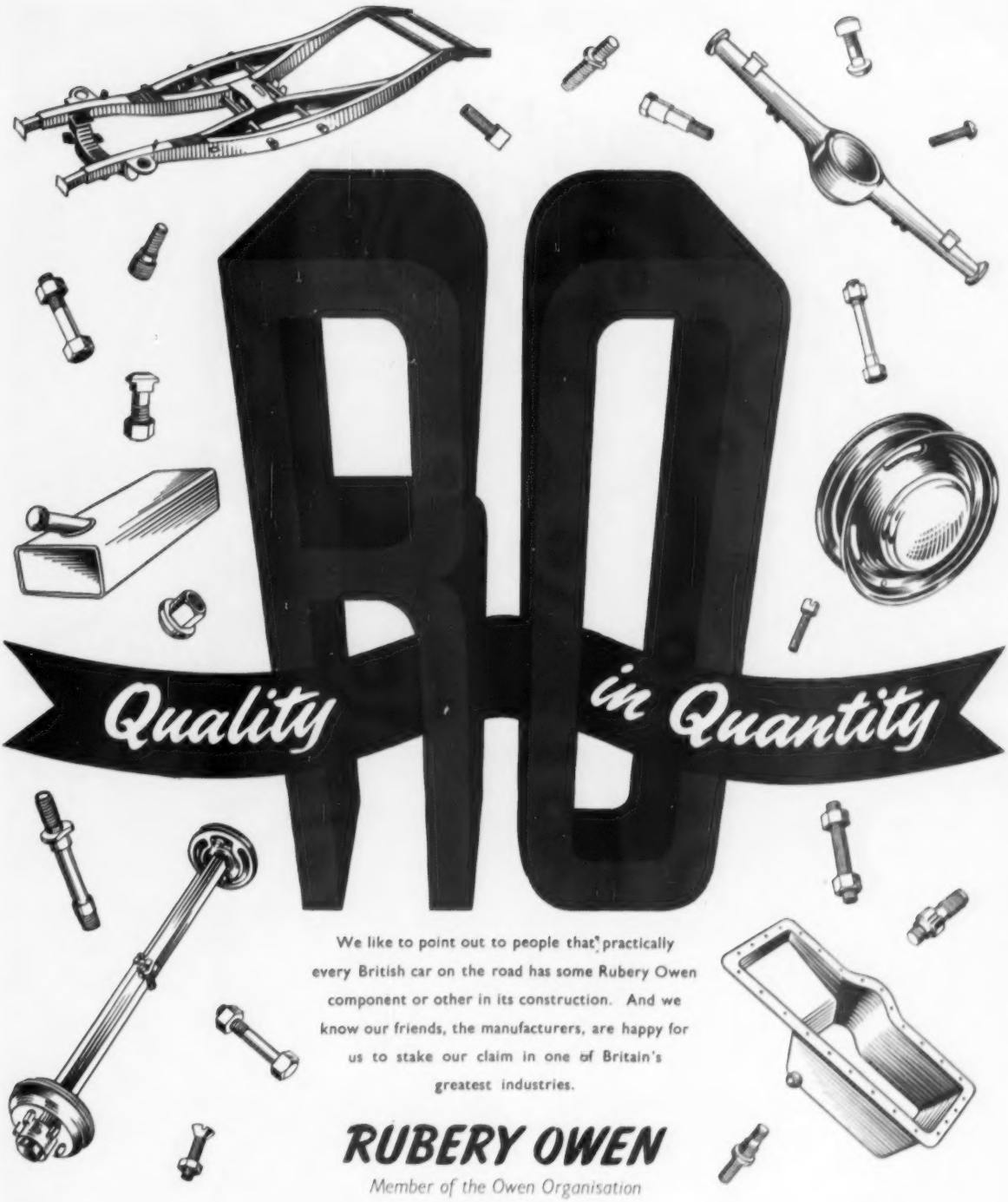

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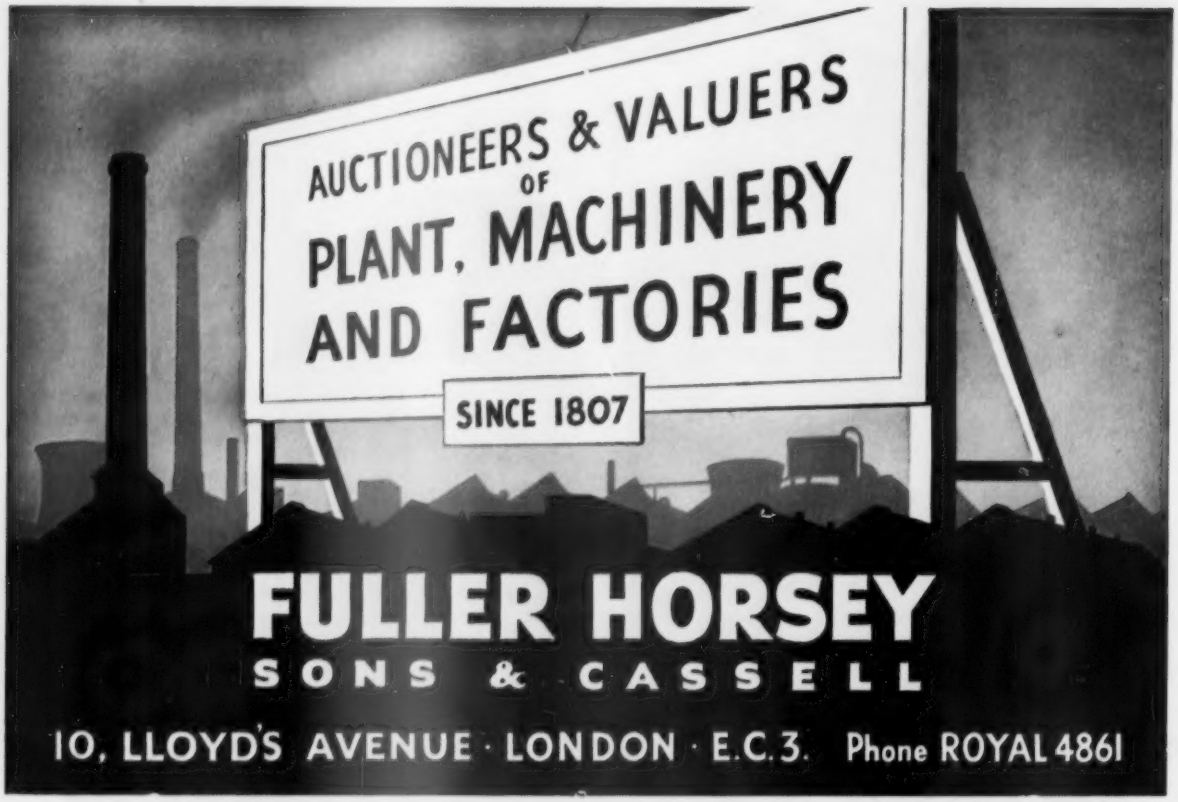
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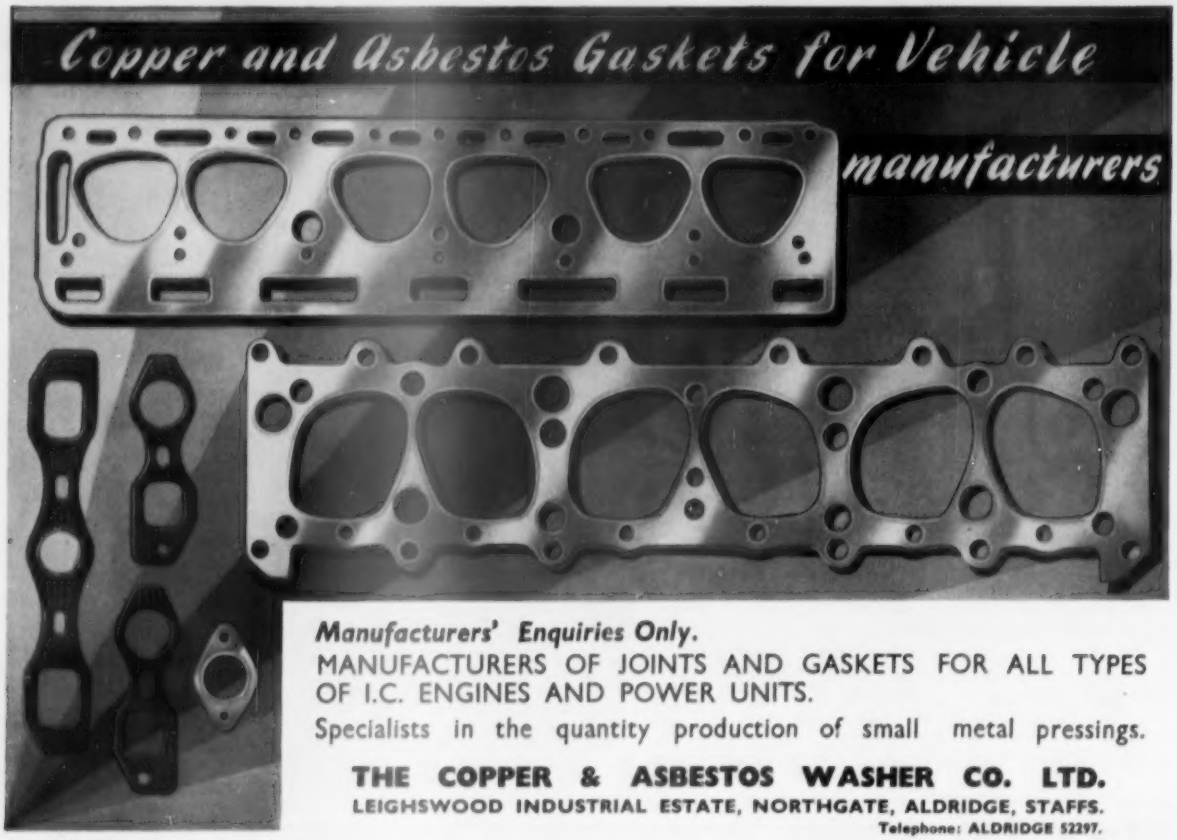
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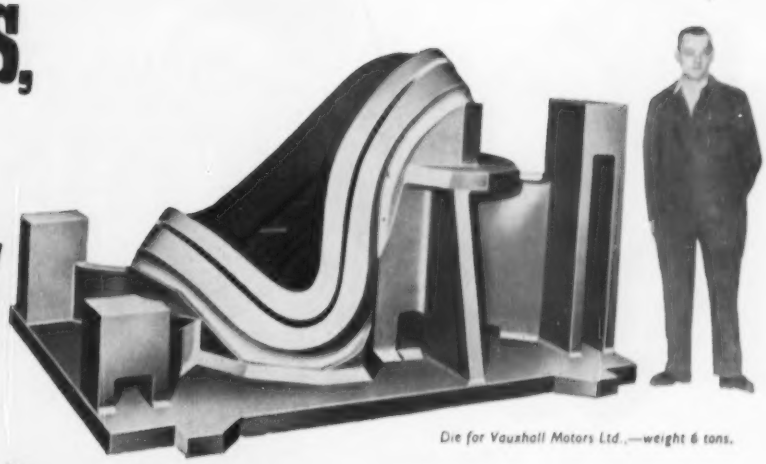

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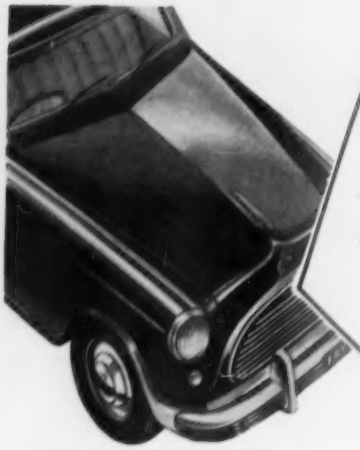

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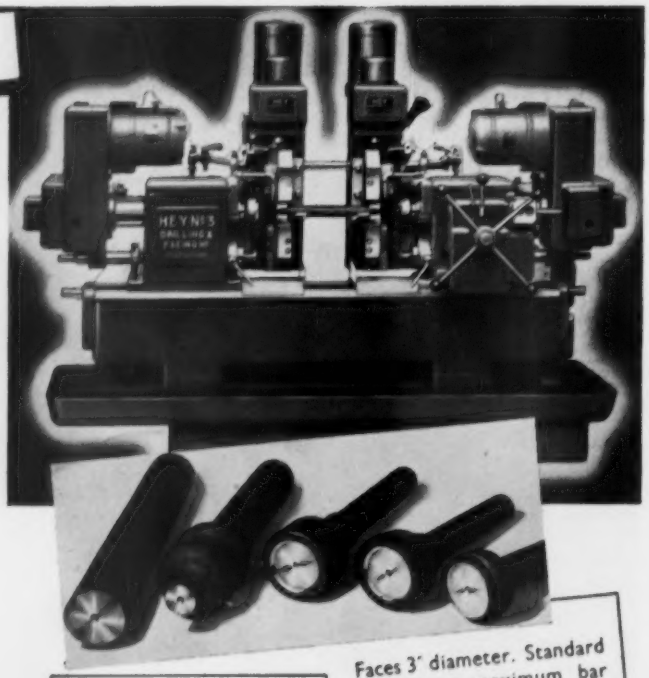

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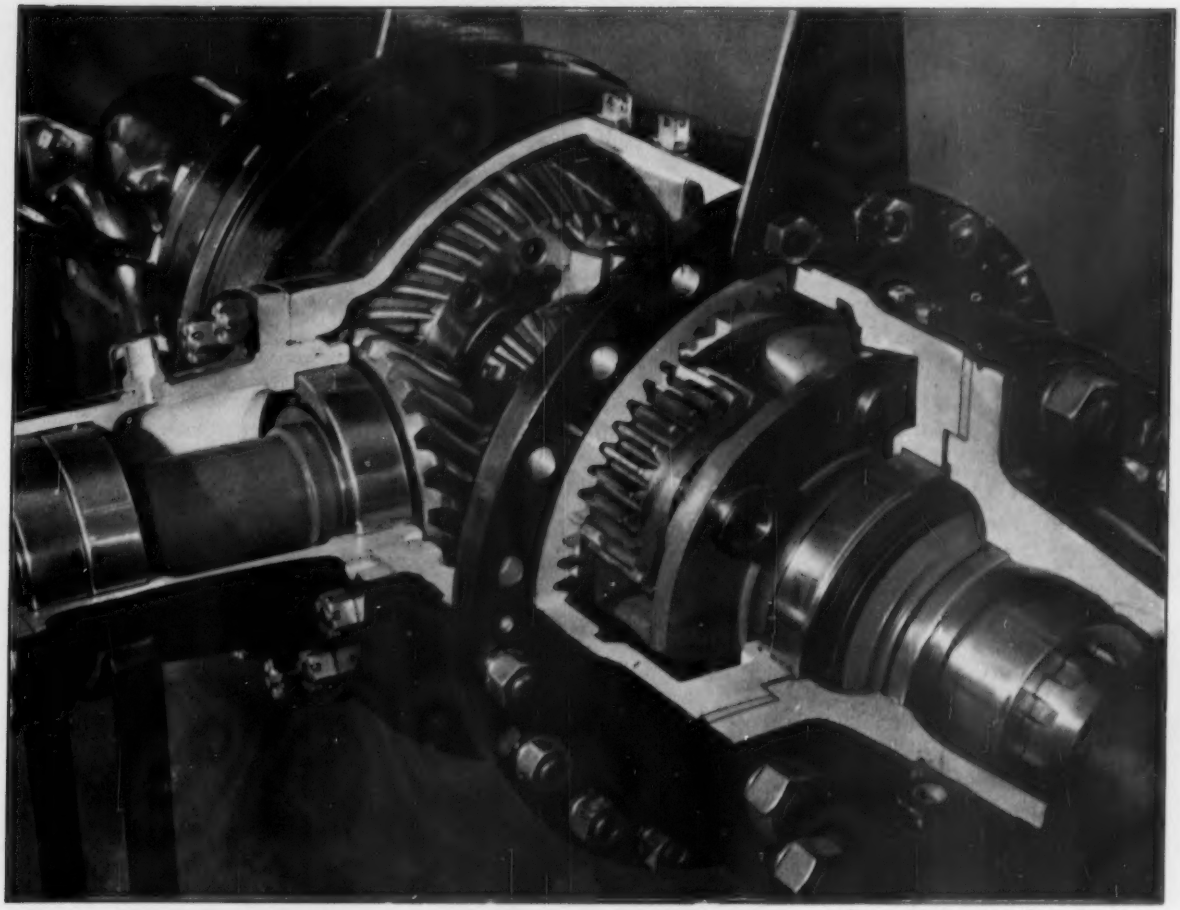

Differential gear assembly in Heavy Duty Driving Axle.

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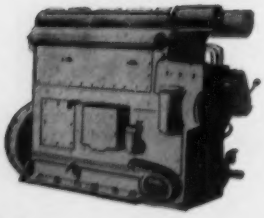

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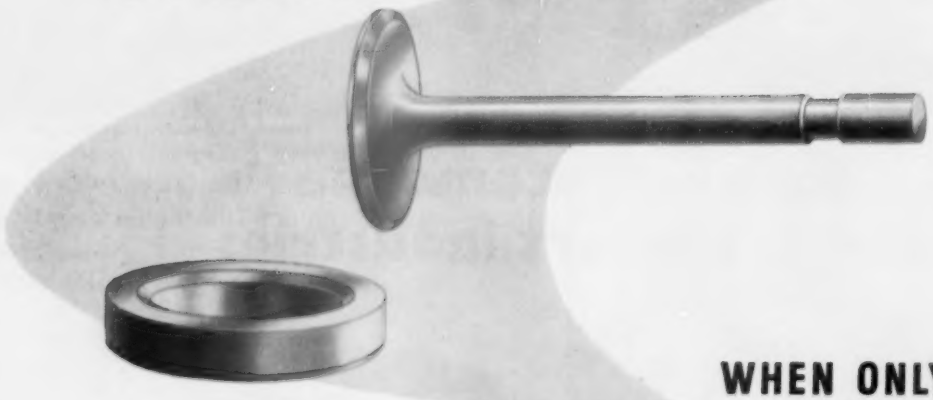

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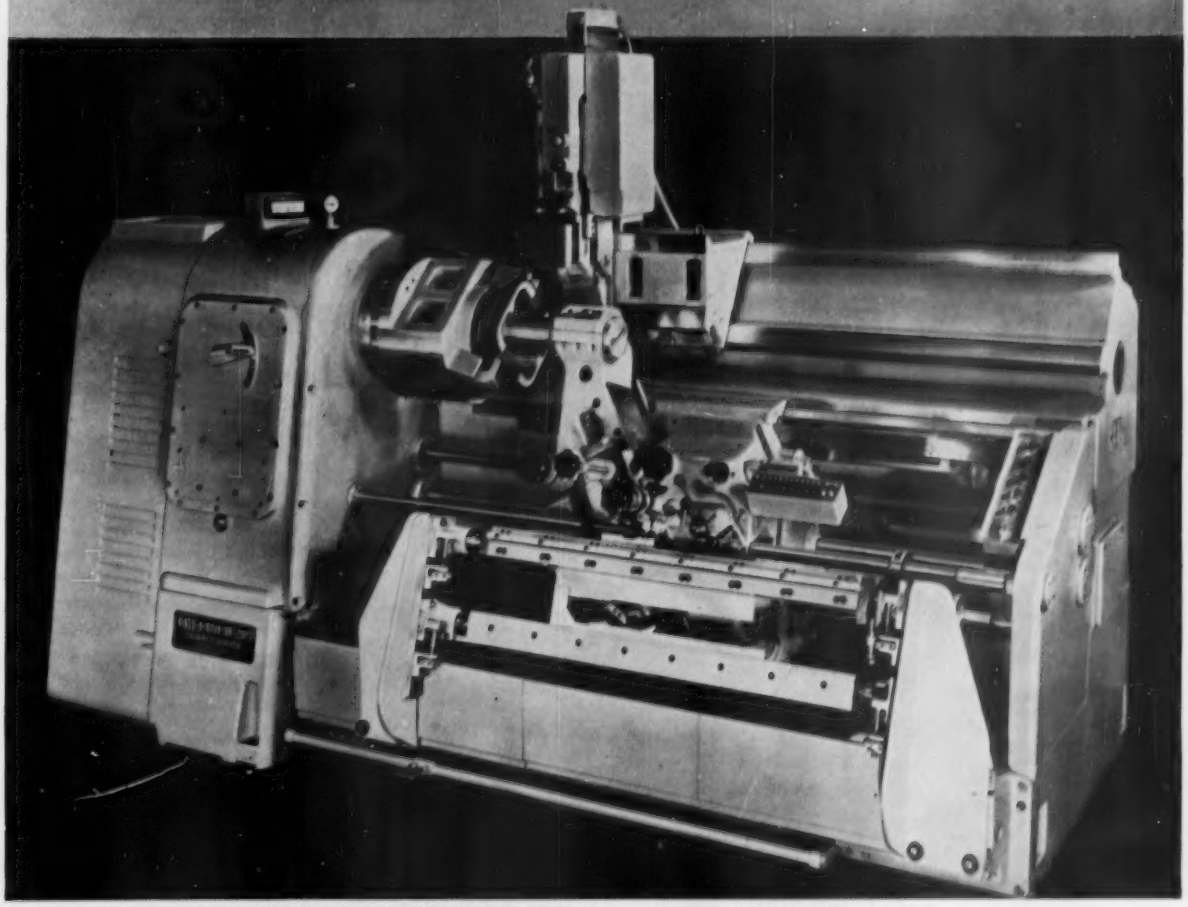

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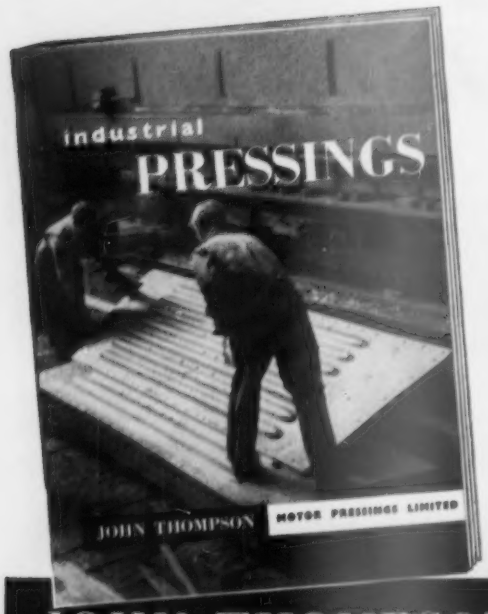

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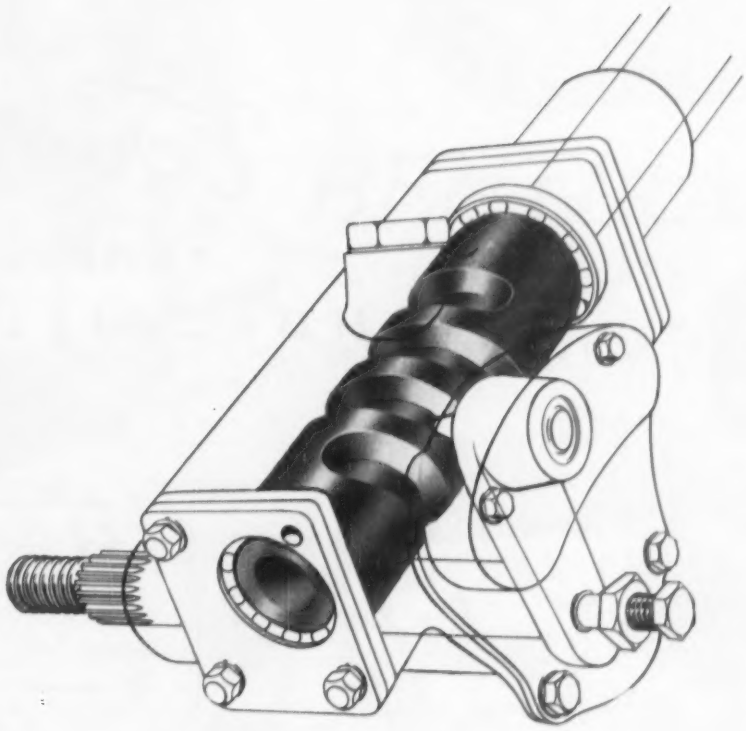

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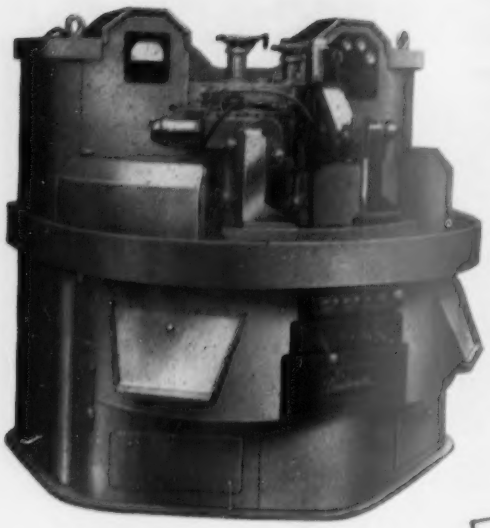

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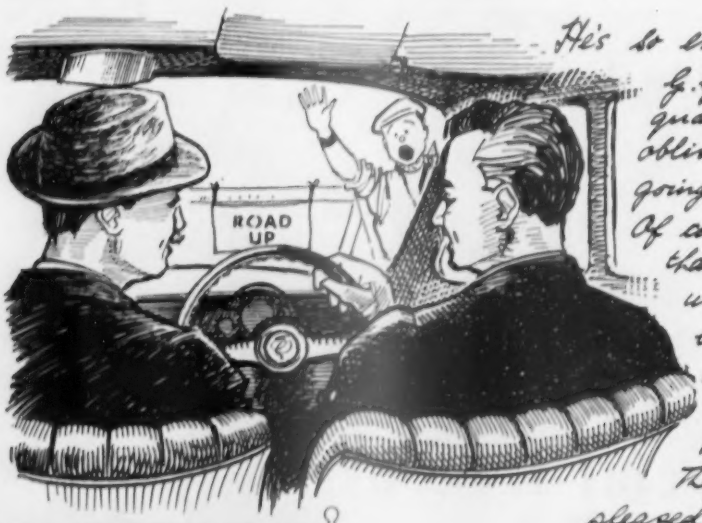

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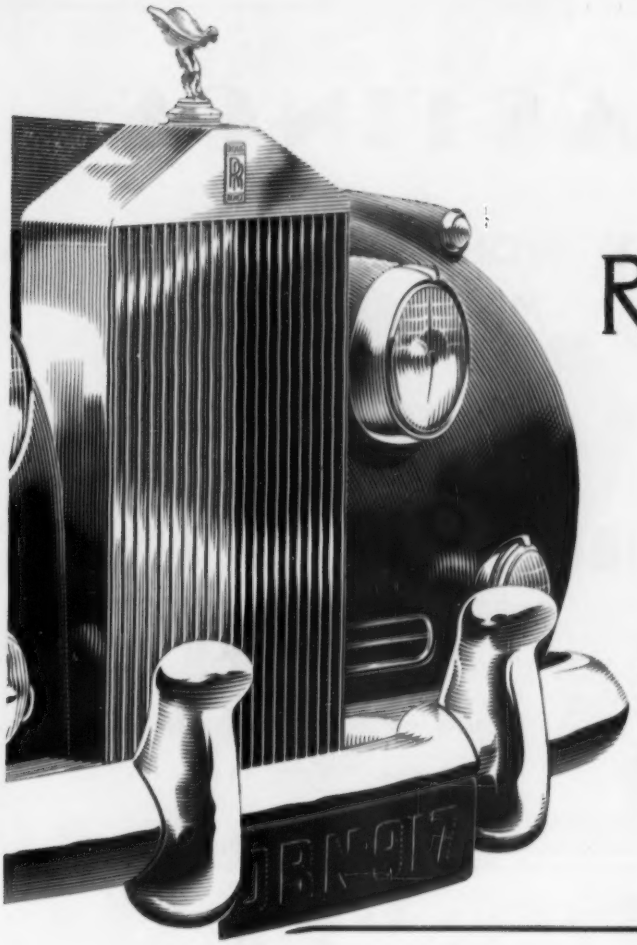

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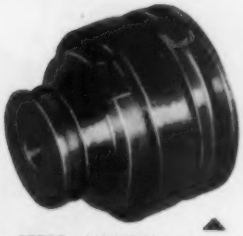

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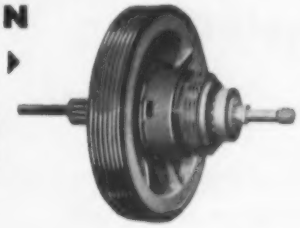

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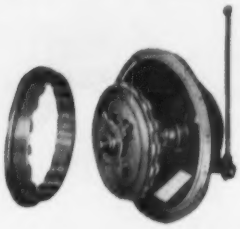

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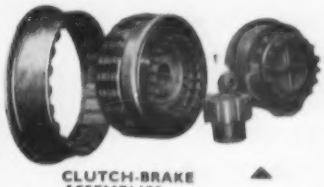

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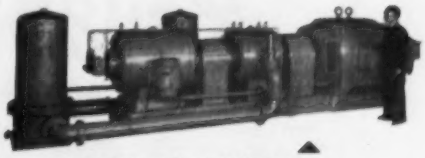

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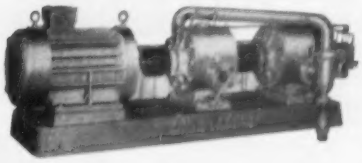

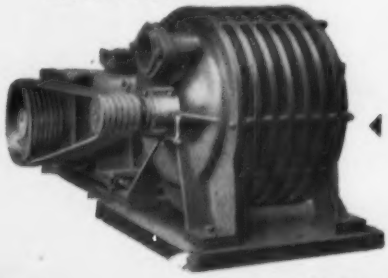

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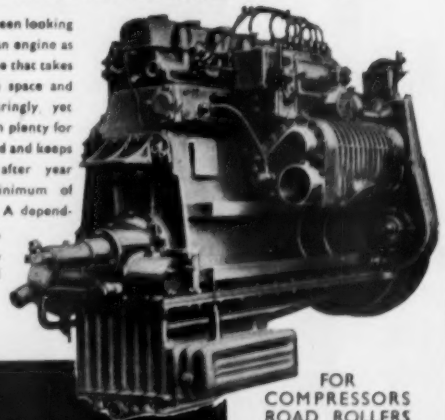

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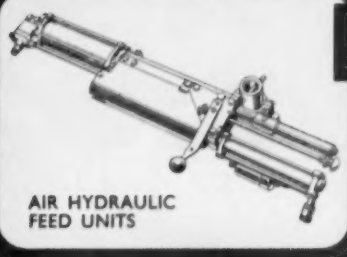

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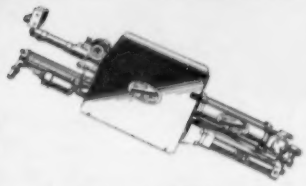

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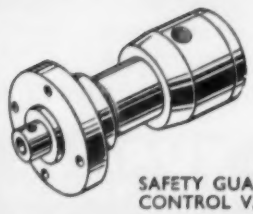

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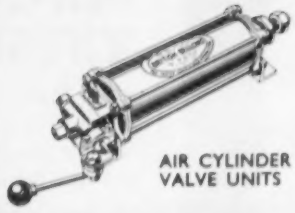

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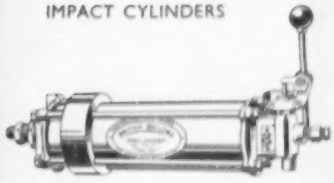

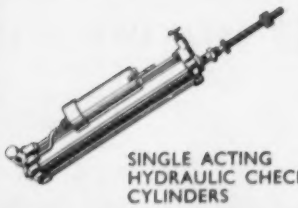

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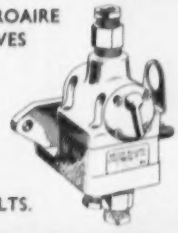

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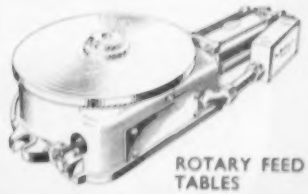
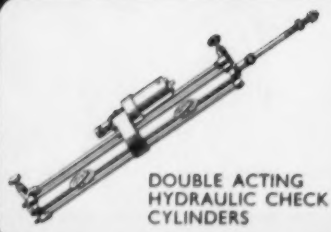


ROTARY FEED TABLES



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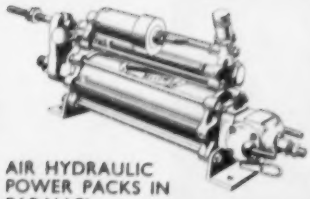

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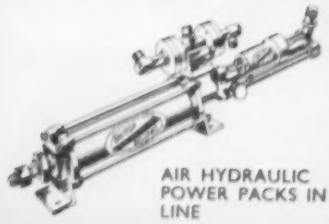

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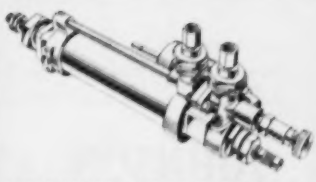

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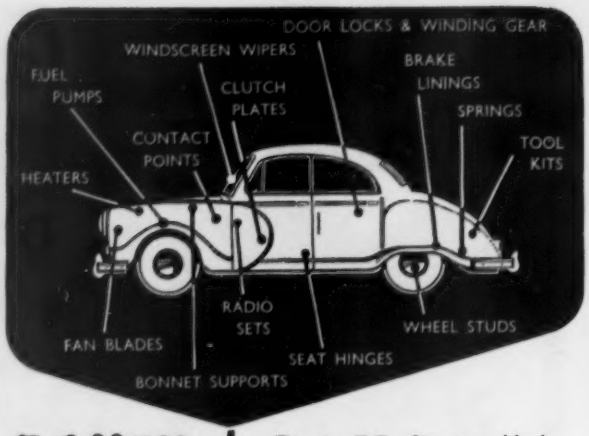

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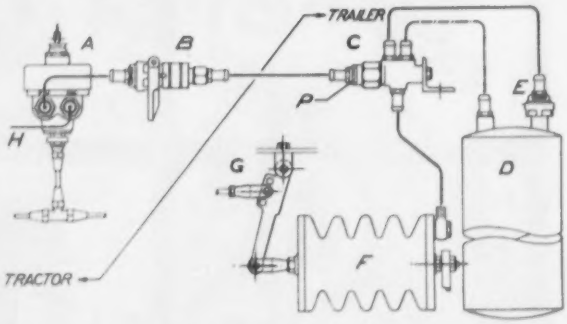

A. Hydraulic Reaction Valve LV 207 Dual Control, shown fitted to Hydraulic Pipe Line on Tractor.

B. "C" type Coupling with Auto. Shut-off Valve, attached to rear of Tractor.

C. Breakaway Valve SBS. 256 (or SBS. 257) attached to Tow Bar of Trailer.

D. Vacuum Tank on Trailer.

E. Non-return Valve.

F. Power Unit on Trailer operating linkage "G" to Trailer Brakes.

H. Hose connecting LV 207 to source of Vacuum Hose connections shown as solid lines are those used in normal operation of Brakes.
The Hose shown in broken line connects the Vacuum Tank to the Power Unit when Valve "C" is operated in emergency.

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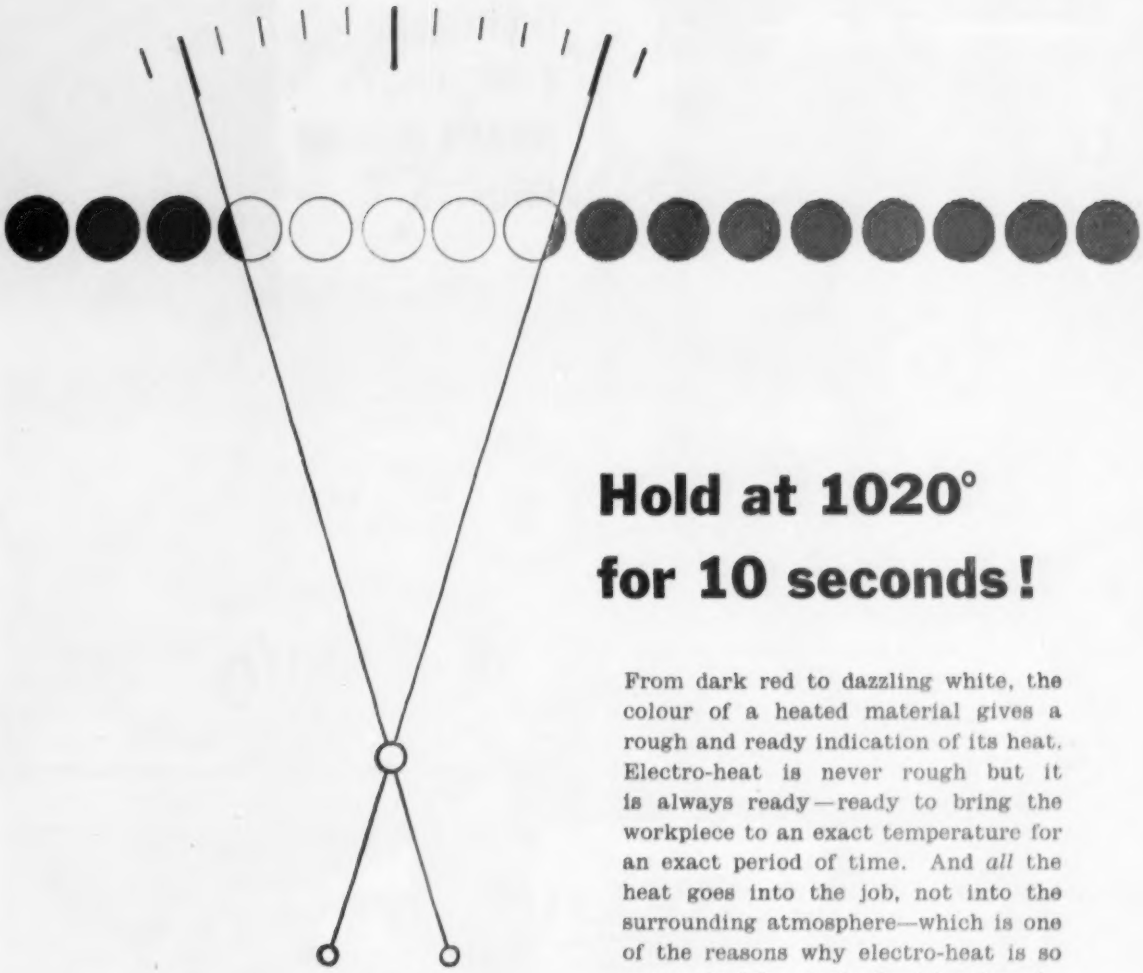

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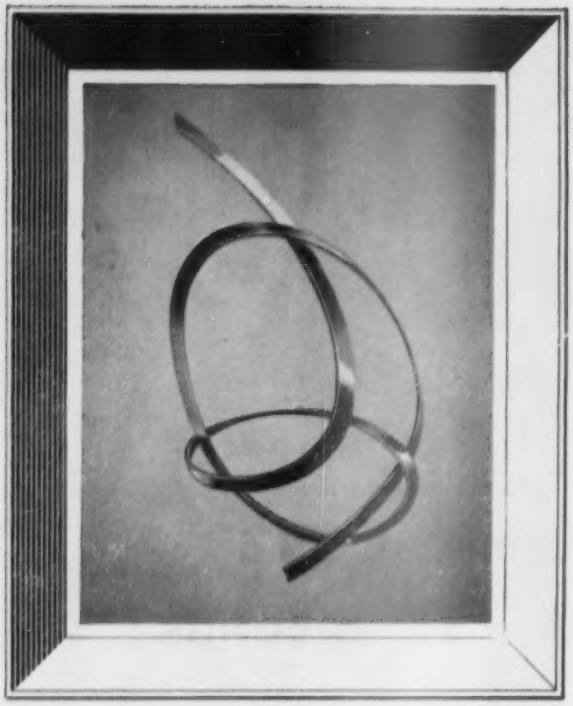

Portrait of a Piston Ring

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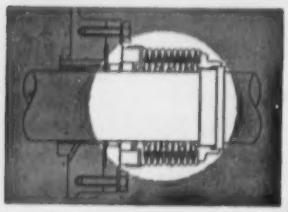

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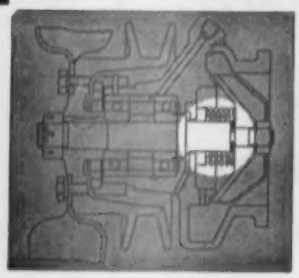

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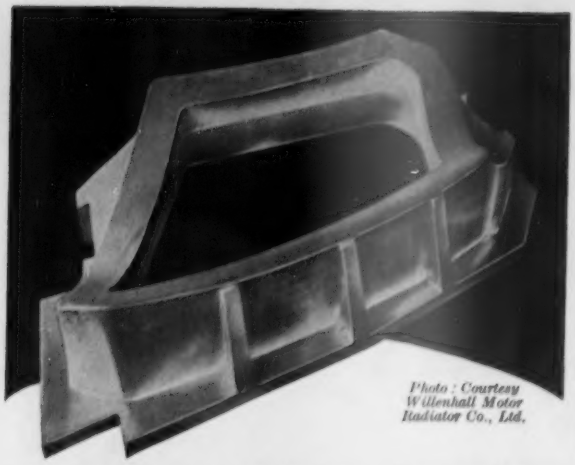

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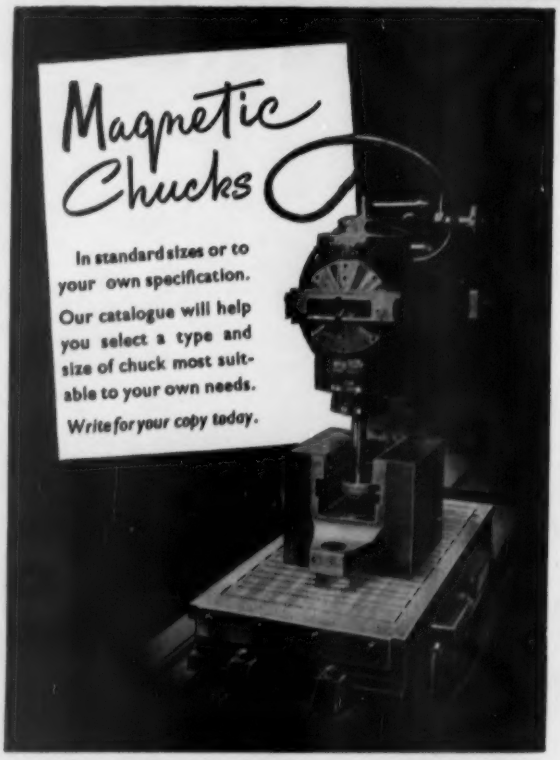
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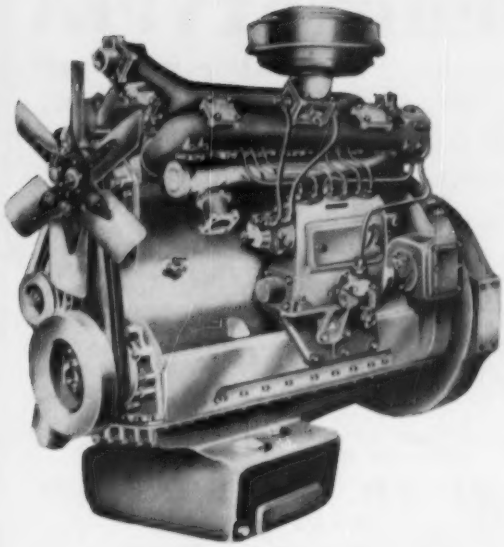

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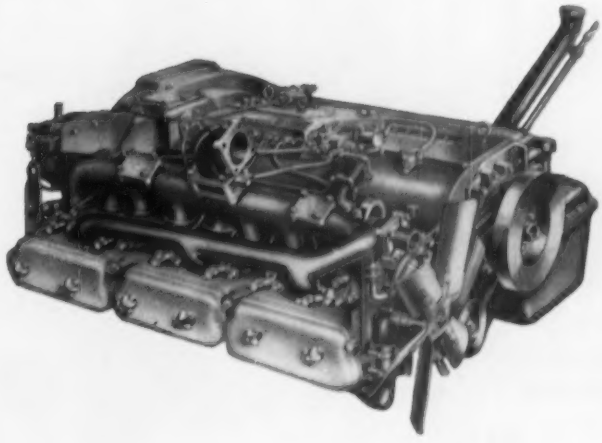

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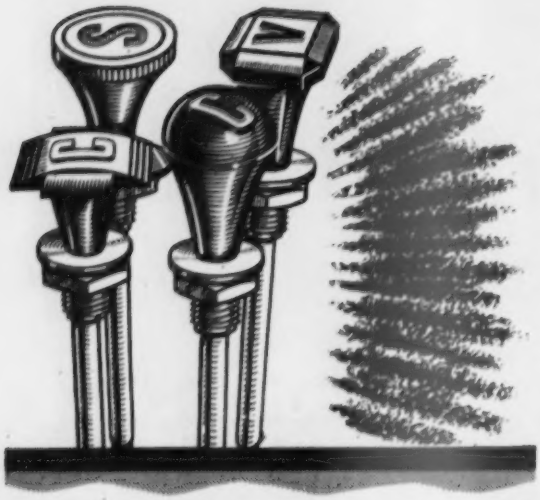

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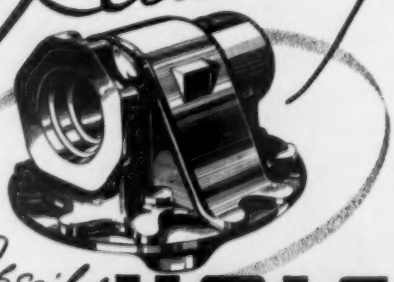

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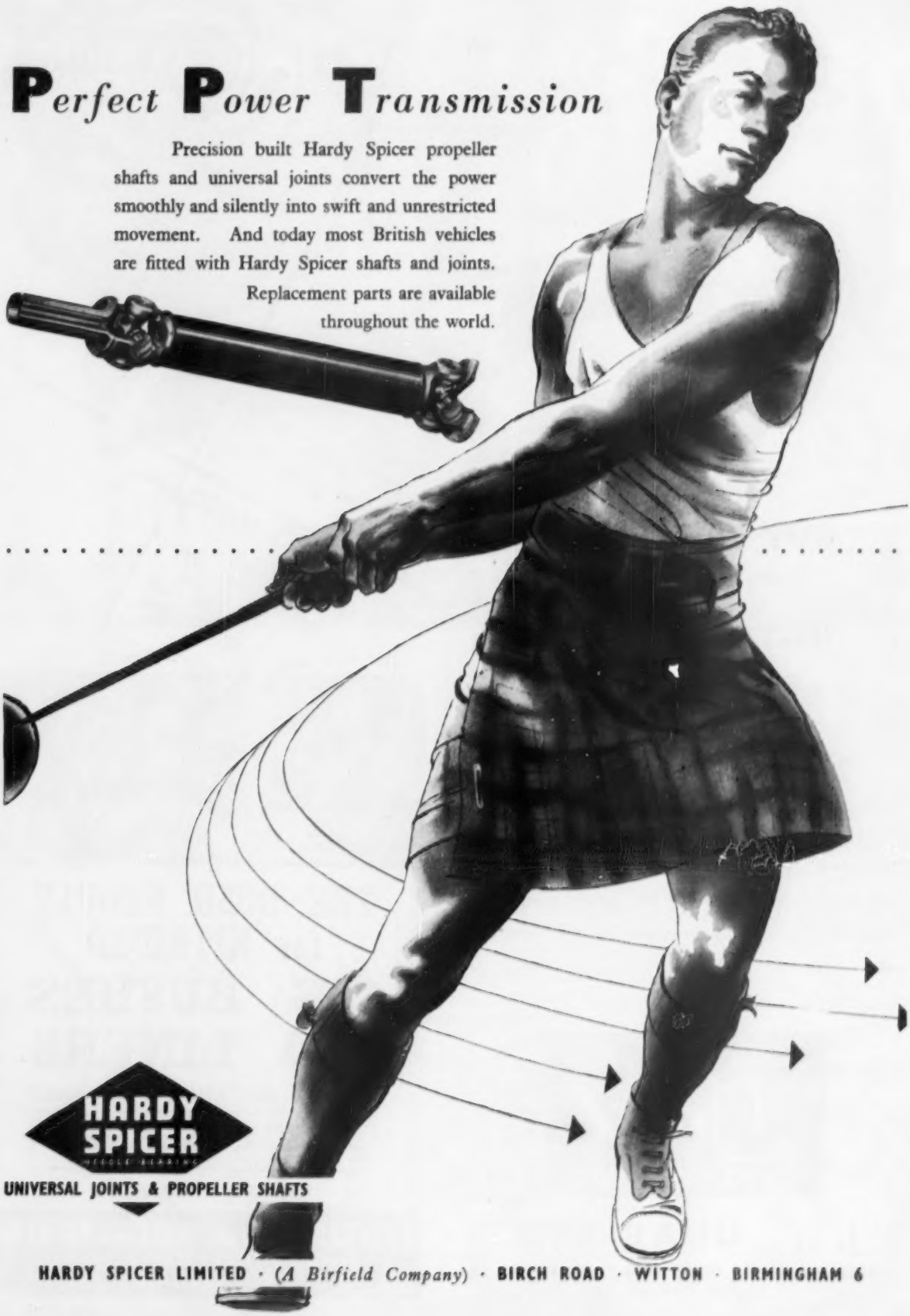

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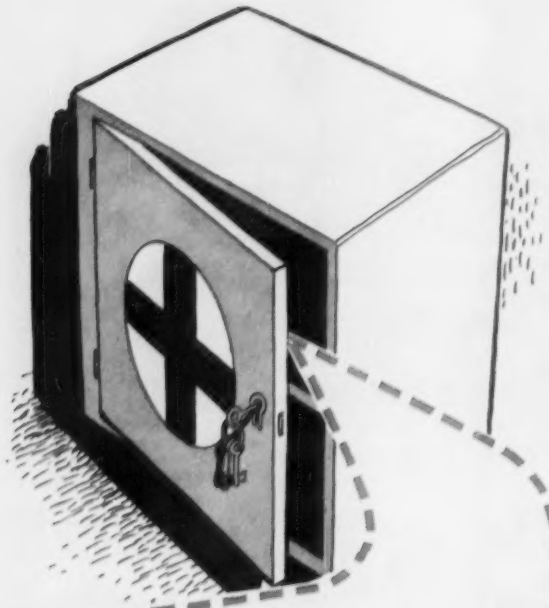

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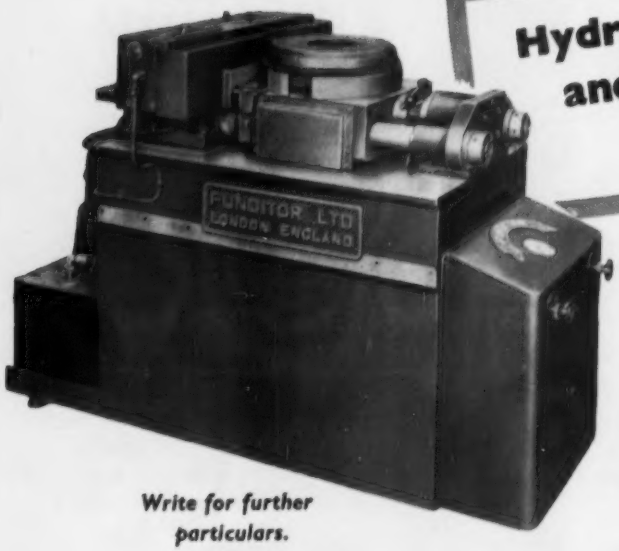

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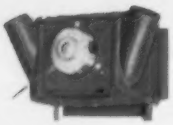

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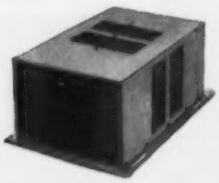

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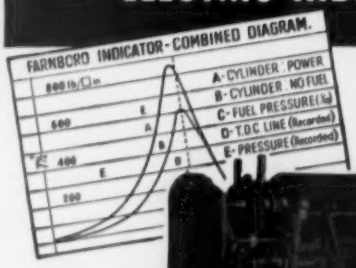

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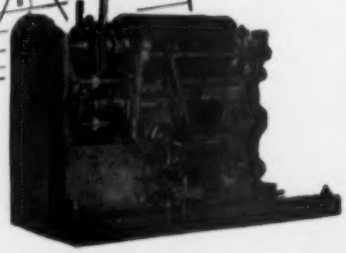

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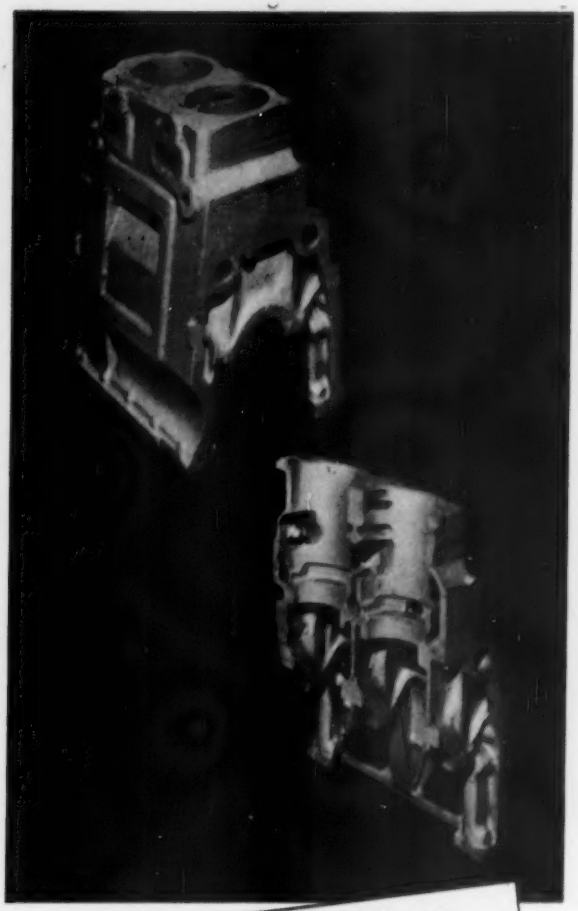

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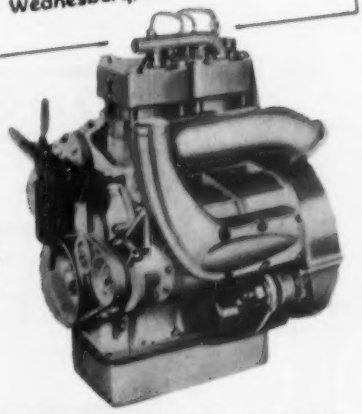

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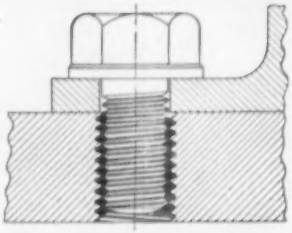

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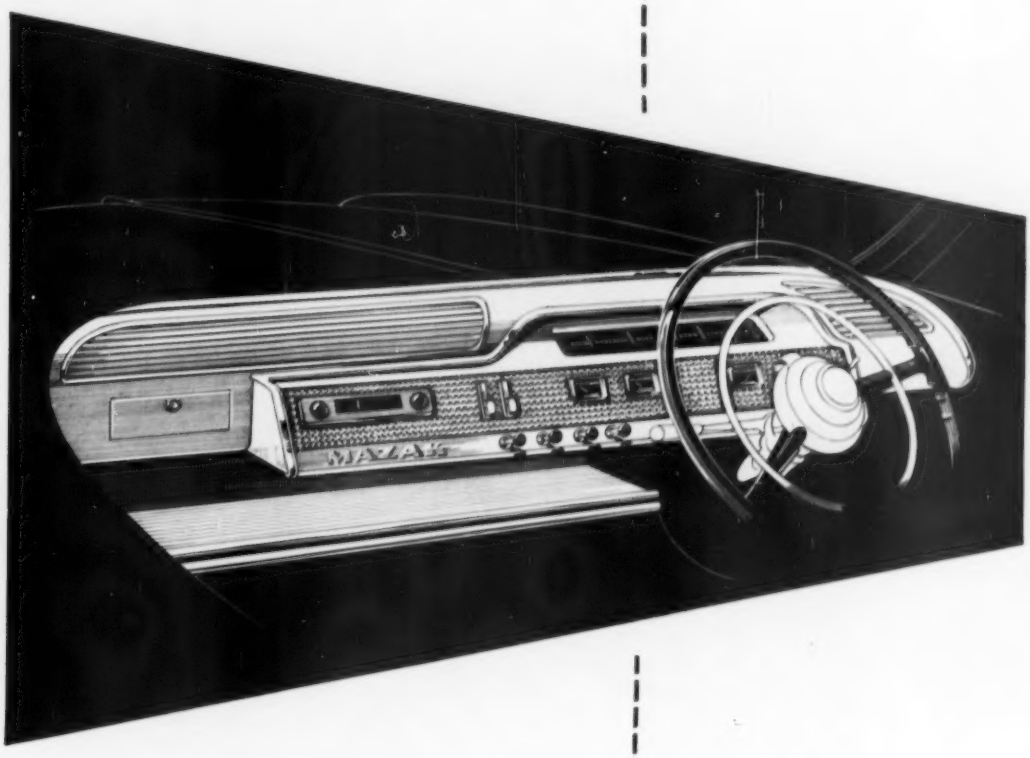

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